

APPENDIX F – OTHER STUDIES

**DRAFT MARINE SEAGRASS SURVEY
FOR
INTRACOASTAL WATERWAY IN THE VICINITY
OF PALM BEACH HARBOR**

October 1998

Contract No. DACW17-94-D-0019
Requisition No. W32CS58259-2718

Prepared for:

**Jacksonville District Office
U.S. Army Corps of Engineers
400 West Bay Street
Jacksonville, Florida 32202-4412**

Prepared by:

**Lotspeich and Associates, Inc.
422 West Fairbanks Avenue, Suite 201
Winter Park, Florida 32789**

December 1998
L&A DOC: AHHD\56042L04.REP

TABLE OF CONTENTS

	PAGE
INTRODUCTION	1
Location	1
Project Objective	1
METHODS AND MATERIALS	1
RESULTS	2
Survey Track Lines	2
Submerged Aquatic Vegetation - SAV	2
RECOMMENDATIONS	3

INTRODUCTION

Location

The site of the seagrass survey was the Intracoastal Waterway (ICW) in the vicinity of Palm Beach Harbor, Palm Beach County, Florida.

Project Objective

The objective of the marine seagrass survey was to document the presence or absence of marine seagrasses where dredging is proposed. If seagrasses were present, the location, density and acreage would be documented. Density was characterized as patchy, sparse, moderate or heavy coverage. Of particular concern was the species *Halophila johnsonii*, an endangered species which is known to occur within the survey area and is generally more abundant near inlets.

METHODS AND MATERIALS

A field survey of the ICW in the vicinity of Palm Beach Harbor was conducted to determine the location, density, and acreage of marine seagrasses. The survey was conducted for a distance of approximately six and one-tenth miles (33,000 feet). The southern limit of the survey was approximately 2,000 feet south of State Road 704 (Royal Park Bridge, Cut P-41) and extended north of Palm Beach Harbor to the State Road 708 Bridge (Cut P-34, Blue Heron Boulevard). Transects perpendicular to the ICW were surveyed at approximate 100 foot intervals. Transects extended a minimum of 100 feet to each side of the center of the existing navigation channel. Strong winds during the survey period associated with tidal currents often made exact positioning of the survey vessel difficult. Winds were particularly adverse on October 23 and 27, blowing in excess of 25 knots from the north and northeast, and predetermined survey tracks could not be maintained.

Bottom type was documented with video received from a towed underwater camera, and recorded on Hi-8 mm video format. The video was copied to VHS format tape and will be presented with the final report.

Position based on geographic (latitude, longitude) start and end points for each transect were calculated prior to conducting the field survey. These positions were used as locating points to maintain transect spacing. The transect navigation track was recorded on a laptop computer coupled with an Apelco 560 fishfinder with an integrated differential global positioning system (DGPS).

Vessel position, water column depth, water temperature, and time were recorded every 5 seconds on a laptop computer connected to the NMEA 0183 interface. Vessel speed was adjusted to acquire a satisfactory video image while maintaining a reasonable survey speed. Seagrass locations were noted and logged based on time (hh:mm:ss) which was correlated to the computer logged vessel position.

RESULTS

Survey Track Lines

Figure 1 illustrates the survey area. Coverage segments are color coded by date of survey. Figures 2 - 6 illustrate the survey vessel track lines for each day. The area in the vicinity of Peanut Island was surveyed on both October 27 and October 30, 1998. Additional coverage was obtained on October 30 to supplement the data of October 27 which was collected under adverse weather conditions. This area was also where the majority of seagrasses were located.

Submerged Aquatic Vegetation - SAV

There was considerable SAV located within the survey area within the northernmost section. This area, in the vicinity of Peanut Island, receives the benefits of clean water exchange through the Lake Worth Inlet. Four species of seagrasses were observed within the survey area: *Halodule wrightii*, *Syringodium filiforme*, *Thalassia testudinum*, and *Halophila englemannii*. The species of *Halophila* was confirmed by retrieving several specimens for identification in the laboratory. The threatened seagrass, *Halophila johnsonii*, was not directly observed. However, due to their small size, species of *Halophila* cannot be differentiated reliably by the survey method used since blade placement, length, and morphology must be considered for species identification.

Exclusive of the deep harbor, the area near the inlet appeared to be very suitable habitat for seagrass growth. In this area, there is substantial exchange of bay water with the relatively cleaner ocean waters. The substratum predominantly consists of medium to fine quartz sands with varying quantities of shell material. Patches of rock occur naturally in the vicinity of Peanut Island, to the immediate south of the Harbor and at occasional places further south near the ICW. The patches of rock supported communities of epifauna and flora (live-bottom) and were usually dominated by red algae. Sponges were also present at some of these locations.

Patches of seagrass were quite abundant within the ICW to the west and north west of Peanut Island (Cut P-35). There were also notable patches of seagrass to the immediate south of the Harbor. Species composition of the patches varied. *Halodule* and *Halophila* were the most abundant of the species within the surveyed area. In general, *Halodule* was limited to the very shallow periphery of the survey. In contrast, the patches of *Halophila* were the deepest occurring of the seagrass. The effect of the *Halophila* colonies on the substratum was visually notable, acting as a binding agent, with the patches often having the appearance of raised mounds. The substratum of the *Halophila* patches was most often fine sand. A small number of specimens were returned to the laboratory for verification and exhibited flowers and fruiting bodies.

Thalassia and *Syringodium* were the least abundant of the seagrasses within the survey area.

Seagrasses coverage diminished markedly to the south of the Harbor. A thick algal mat was found to cover much of the bottom in the southern portions of the survey area. Accumulations of drift algae were also observed in the southern areas.

Figure 7 illustrates point locations at which seagrasses were observed. Contours of distribution and aerial coverages are being calculated. Figure 8 illustrates the occurrence of patches of *Halophila* sp. *Halophila* followed the trend of seagrasses in general with diminished abundance to the south of the Harbor.

RECOMMENDATIONS

There are substantial seagrass communities present within the ICW in the vicinity of Peanut Island. The presence of the genus *Halophila* is of concern since Palm Beach Harbor falls within the range of the threatened species, *Halophila johnsonii*.

Due to the number of possible seagrass beds within the proposed dredging area, a closer inspection of the *Halophila* is warranted. It is suggested that divers make inspections of as many beds as possible to determine if *Halophila johnsonii* is present. Underwater magnification devices will be required. Small samples taken from each of the beds inspected should also be verified aboard the survey vessel under a dissecting microscope. Inspections should be conducted during peak growing season, Summer of 1999, as Winter die back may make the beds or the plants less conspicuous.

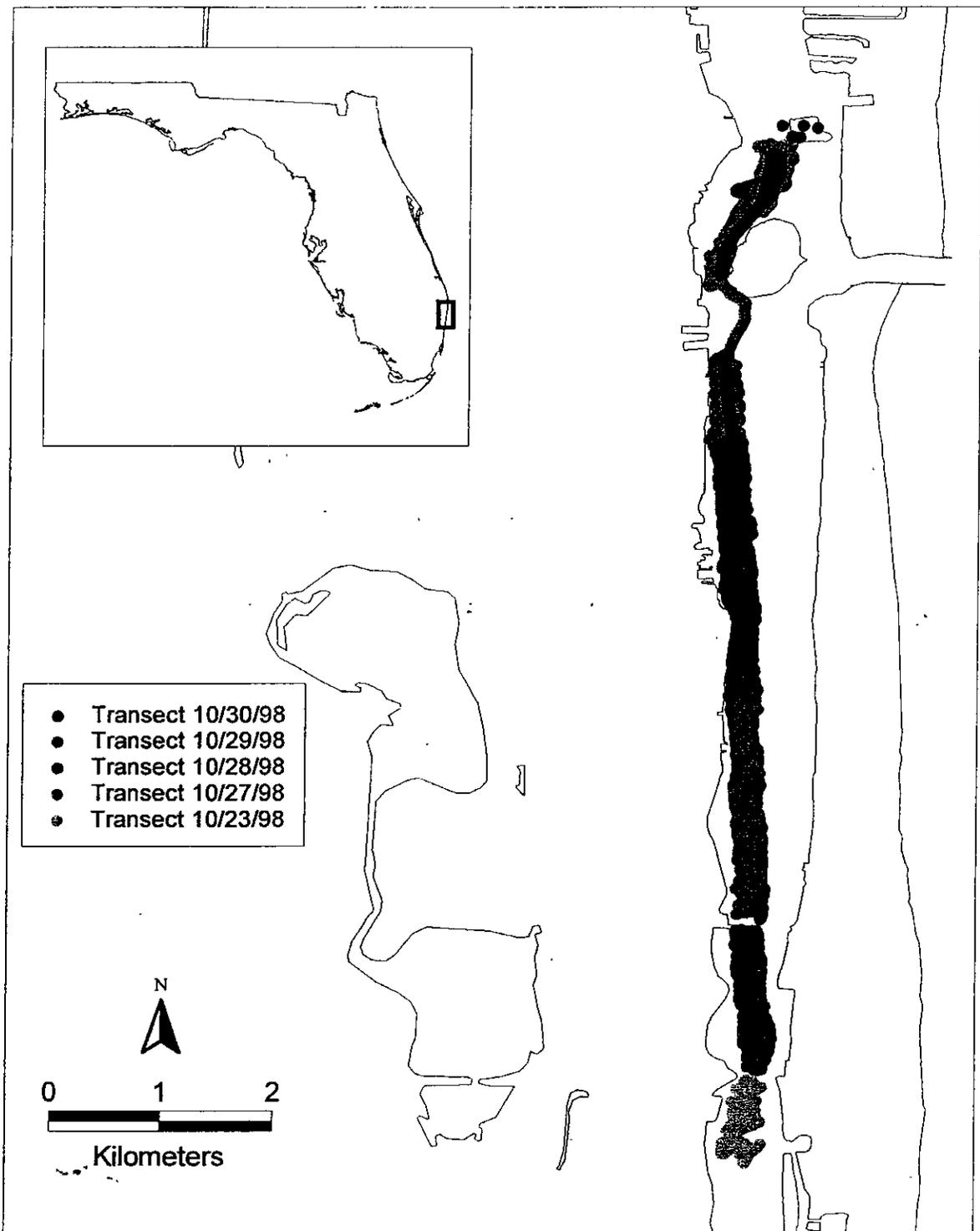


Figure 1. Seagrass survey area in the Intra Coastal Waterway (ICW) in the vicinity of Palm Beach Harbor conducted October 23 to October 30, 1998.

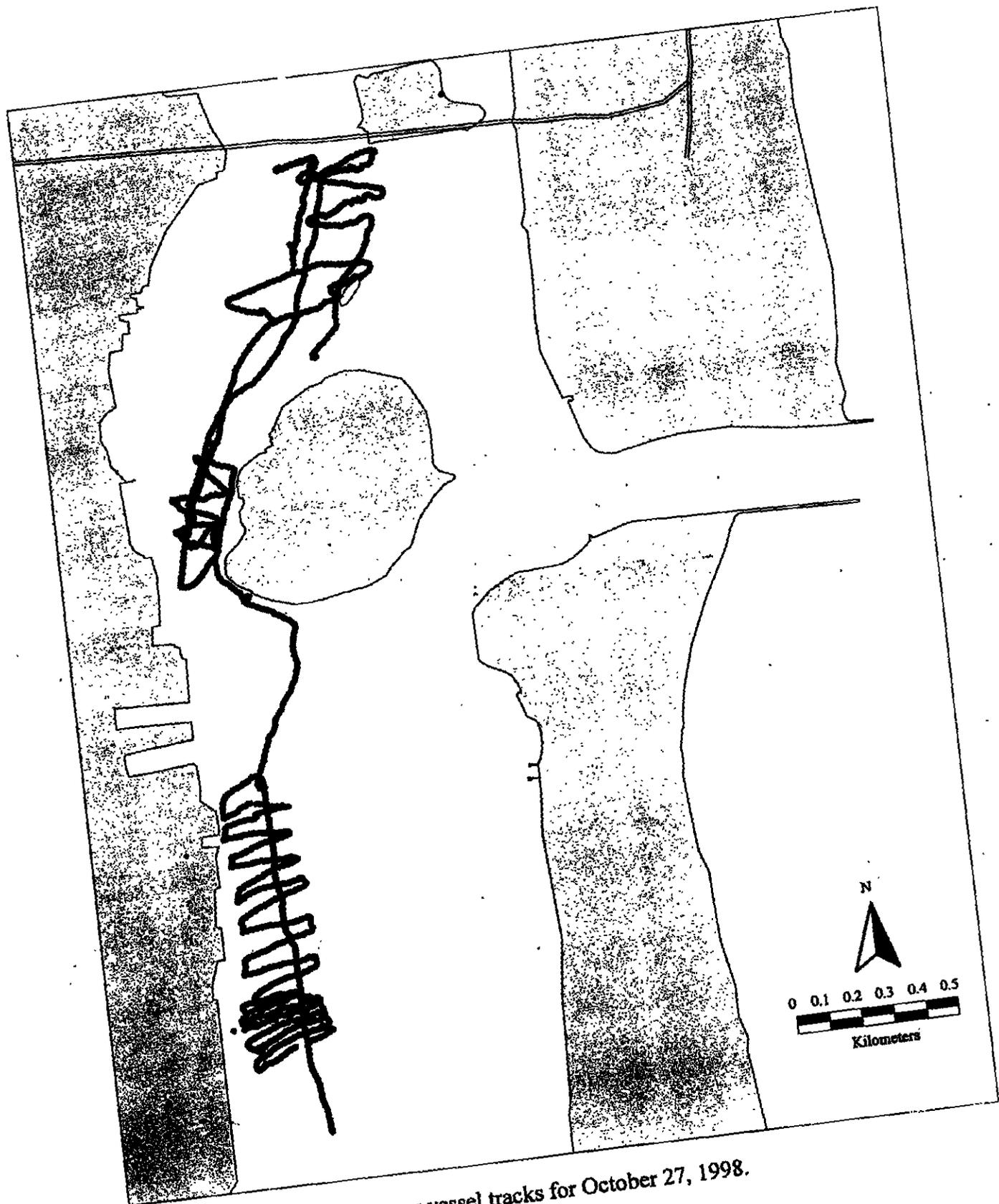


Figure 2. Seagrass survey vessel tracks for October 27, 1998.

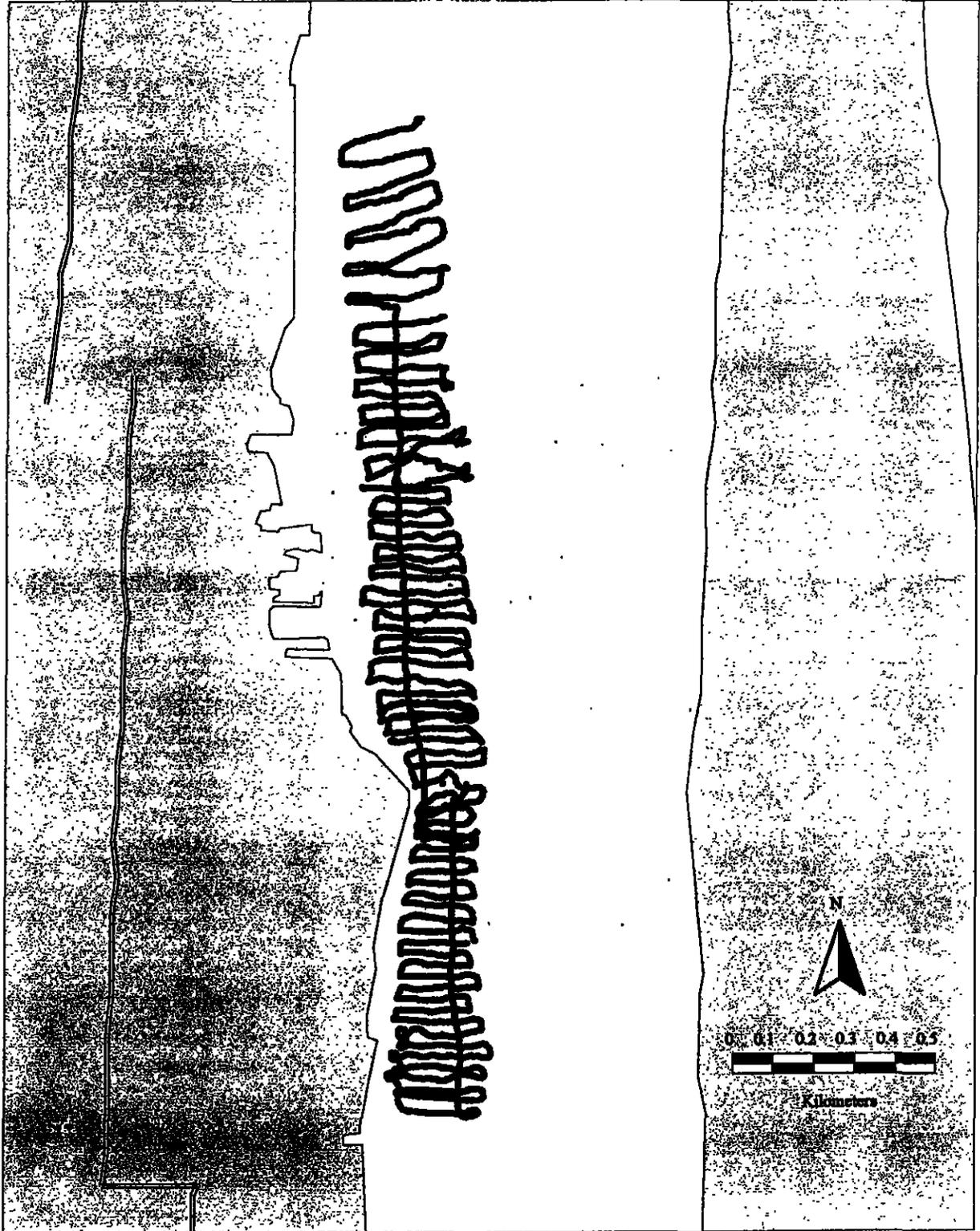


Figure 3. Seagrass survey camera track for October 28, 1998.

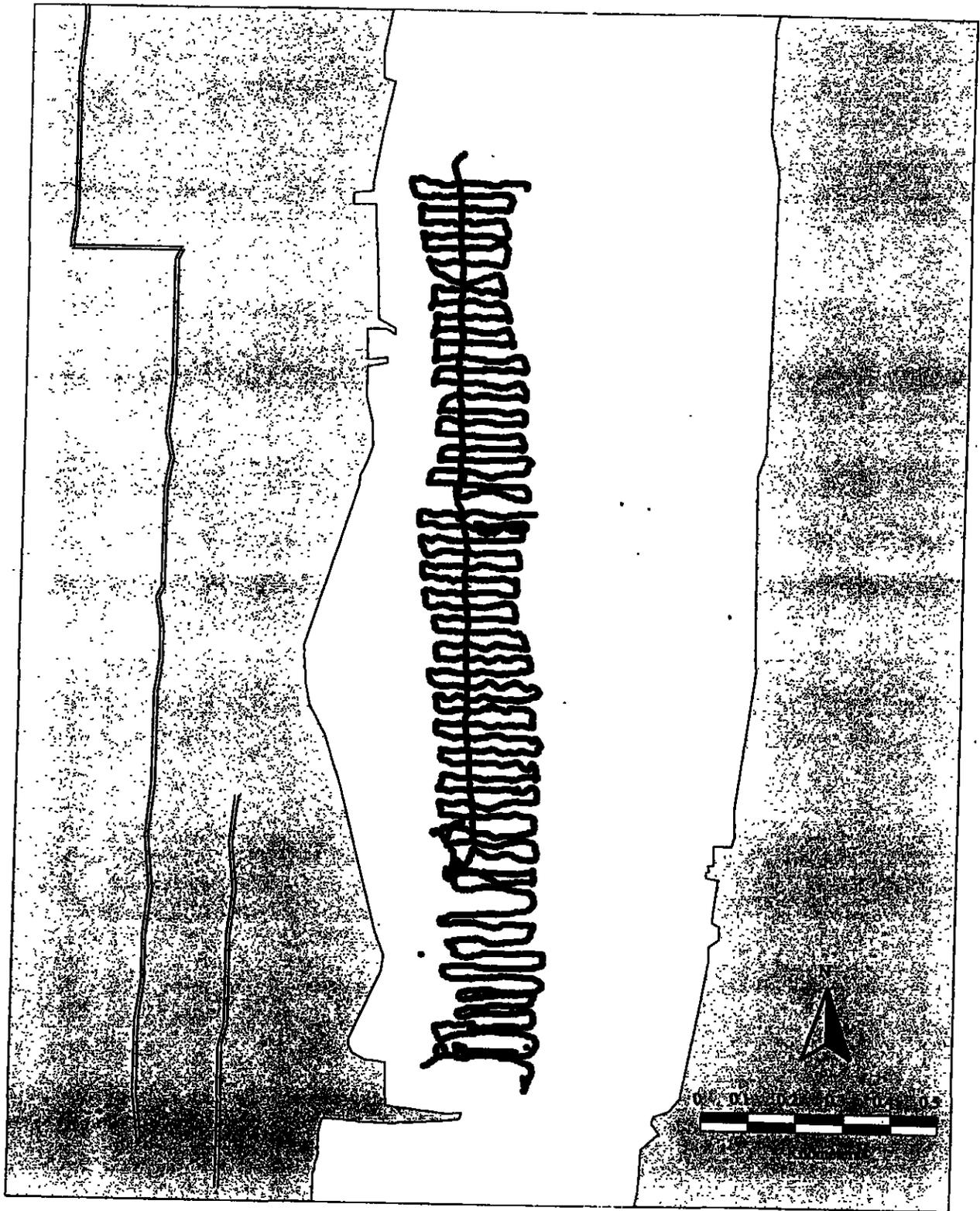


Figure 4. Seagrass survey camera track for October 29, 1998.

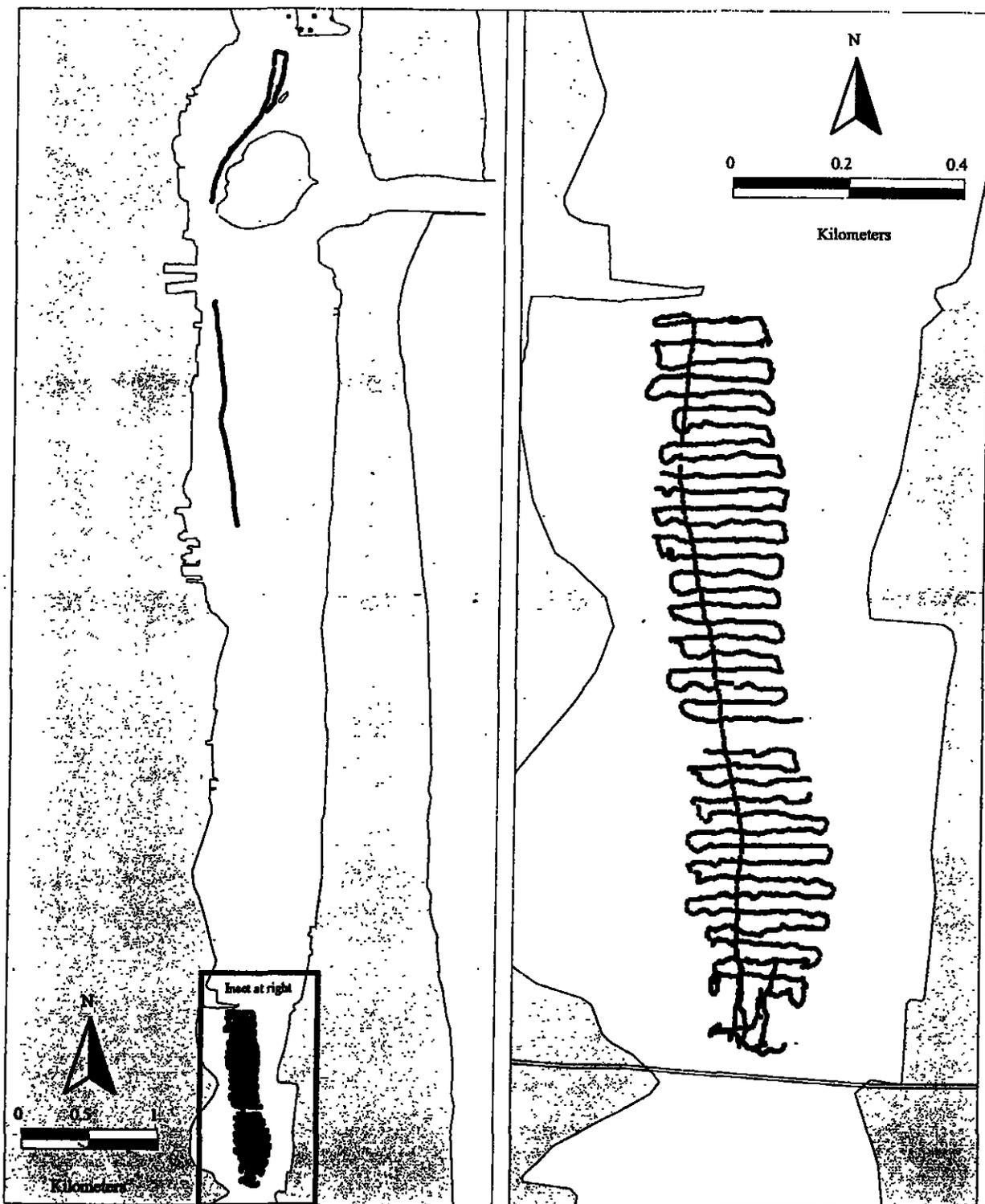


Figure 5. Seagrass survey camera track for October 30, 1998.

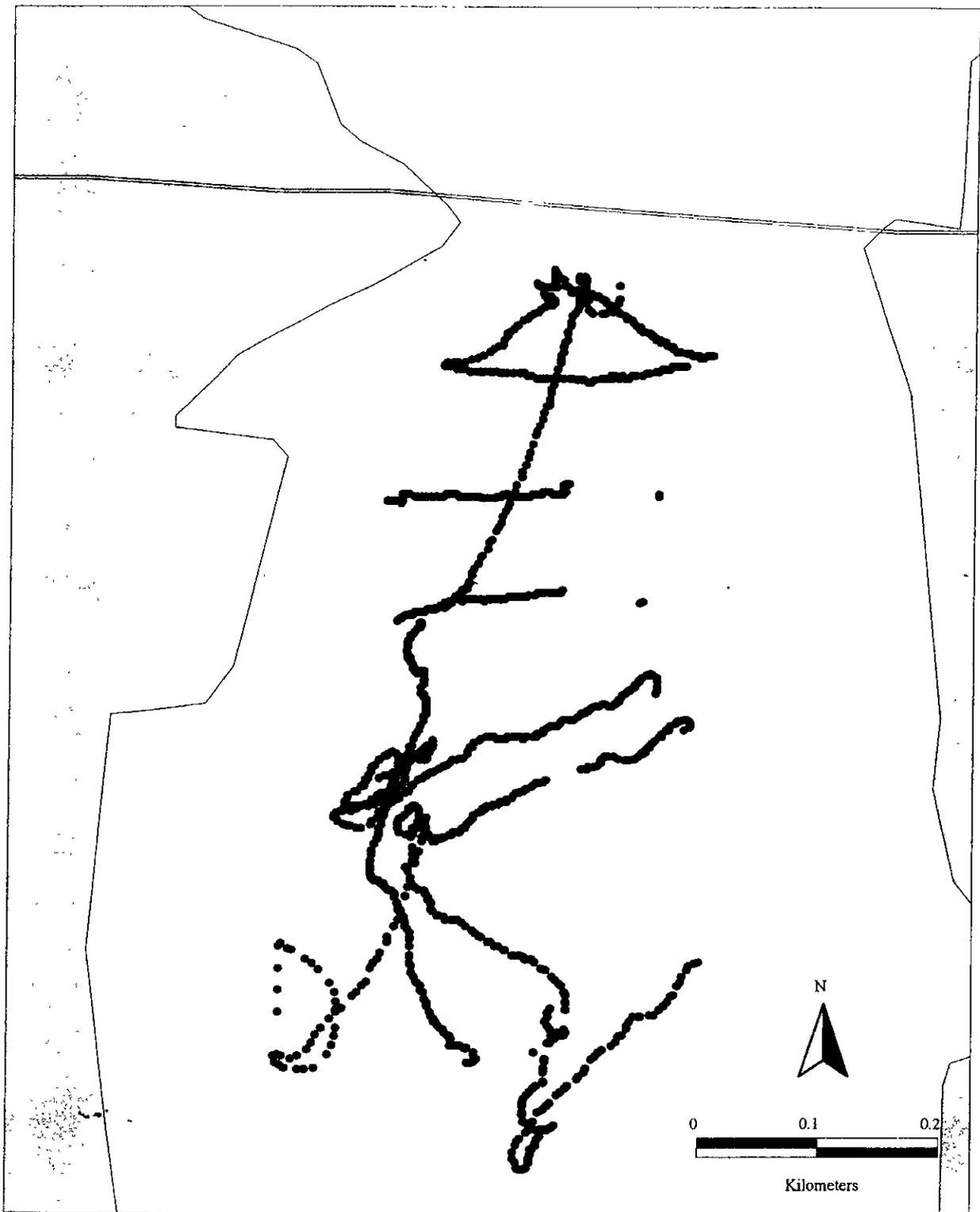


Figure 6. Seagrass survey camera track for October 23, 1998.

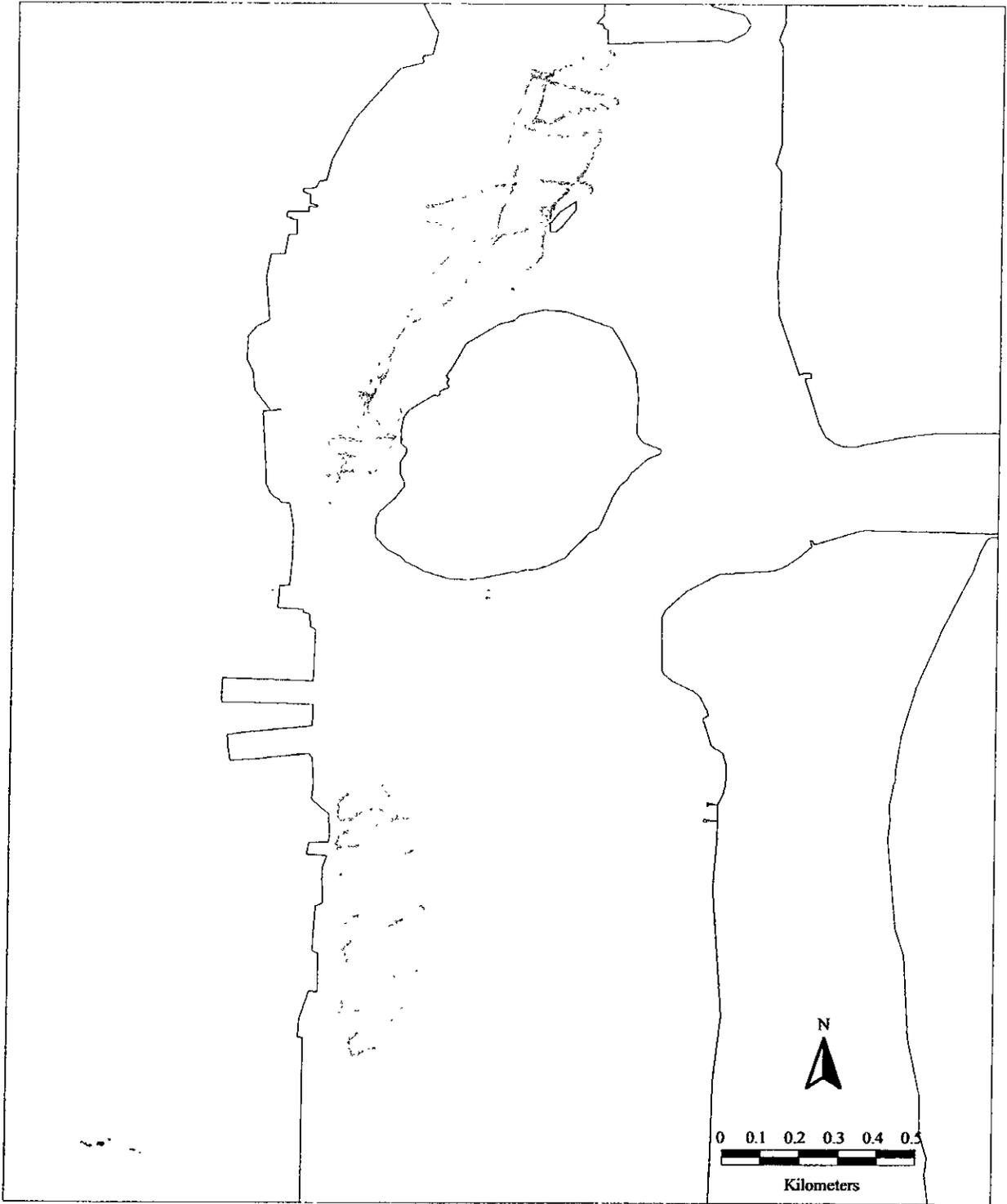


Figure 7. Point locations for detection of all species of seagrasses.

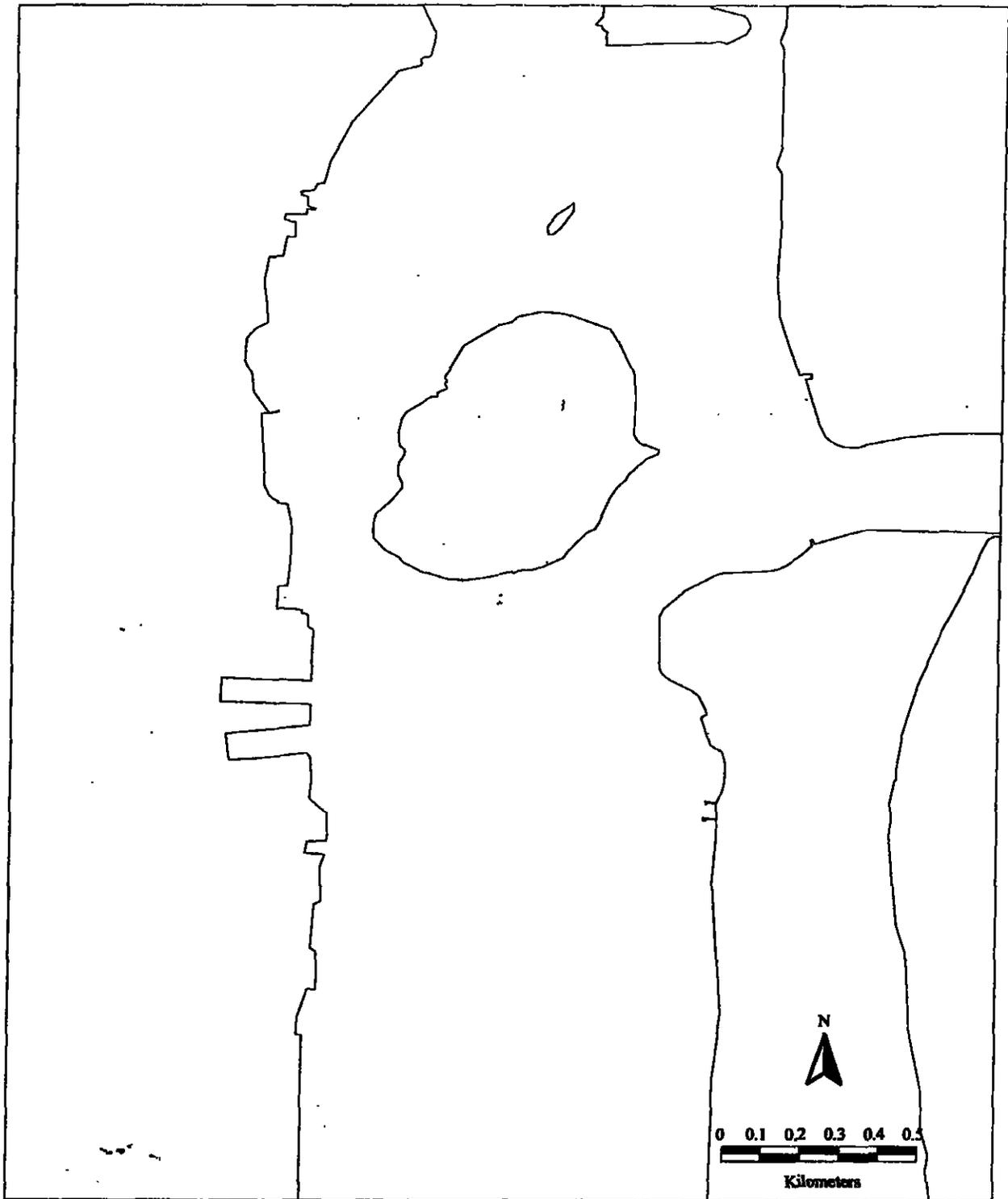
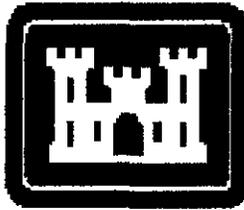


Figure 8. Point locations for detection of patches of the seagrass *Halophila* sp.

**Palm Beach Harbor Lake Worth
Access Channel Expansion
Seagrass Impact Assessment
and
Conceptual Mitigation Plan**

FINAL REPORT



April 24, 2001

**Prepared for:
U.S. Army Corps of Engineers
Jacksonville District
400 West Bay Street
Jacksonville, FL 32202**

**Prepared by:
Dial Cordy and Associates Inc.
490 Osceola Avenue
Jacksonville Beach, FL 32250**

TABLE OF CONTENTS

	Page
LIST OF FIGURES.....	III
LIST OF TABLES	III
1.0 INTRODUCTION	1
1.1 Purpose.....	1
1.2 Background.....	3
2.0 TECHNICAL APPROACH	3
2.1 Impact Analysis.....	3
2.2 Conceptual Mitigation Plan	4
3.0 IMPACT ASSESSMENT.....	5
3.1 Federal Channel	5
3.1.1 Federal Section.....	19
3.1.2 FIND Section	19
3.2 Facilities.....	19
3.2.1 Florida Marine	20
3.2.2 Perry Technologies	20
3.3.3 Charter School	20
3.3.4 Rybovitch Marina	21
4.0 CONCEPTUAL MITIGATION PLAN.....	21
4.1 Site Description.....	21
4.2 Proposed Restoration Design.....	23
4.3 Ecological Benefits of Restoration	29
4.4 Success Criteria.....	29
4.5 Monitoring Plan	30
4.5.1 Pre- Dredging Pilot Study.....	30
4.5.2 Full Scale Restoration.....	30
5.0 LITERATURE CITED	32

LIST OF FIGURES

	Page
Figure 1 Location Map.....	2
Figure 2 Location of Seagrass Communities Subject to Impact.....	18
Figure 3 Existing Seagrass Beds and Bathymetric Contours in Mitigation Area.....	22
Figure 4 Proposed Bathymetric Contours and Estimated Area (ac) to be Filled.....	25
Figure 5 Typical Cross-Section View of Existing and Proposed Elevations (A-A ¹).....	26
Figure 6 Typical Cross-Section View of Existing and Proposed Elevations (B-B ¹).....	27
Figure 7 Typical Cross-Section View of Existing and Proposed Elevations (C-C ¹).....	28

LIST OF TABLES

	Page
Table 1 Seagrass Impacts for Federal Channel, FIND Channel, and Marine Facilities.....	6
Table 2 Project 10-Dredging Impacts on Seagrass Communities, Palm Beach County, FL	7
Table 3 Project 12-Dredging Impacts on Seagrass Communities, Palm Beach County, FL ..	10
Table 4. Project 14-Dredging Impacts on Seagrass Communities, Palm Beach County, FL .	13
Table 5 Project 15-Dredging Impacts on Seagrass Communities, Palm Beach County, FL ..	16

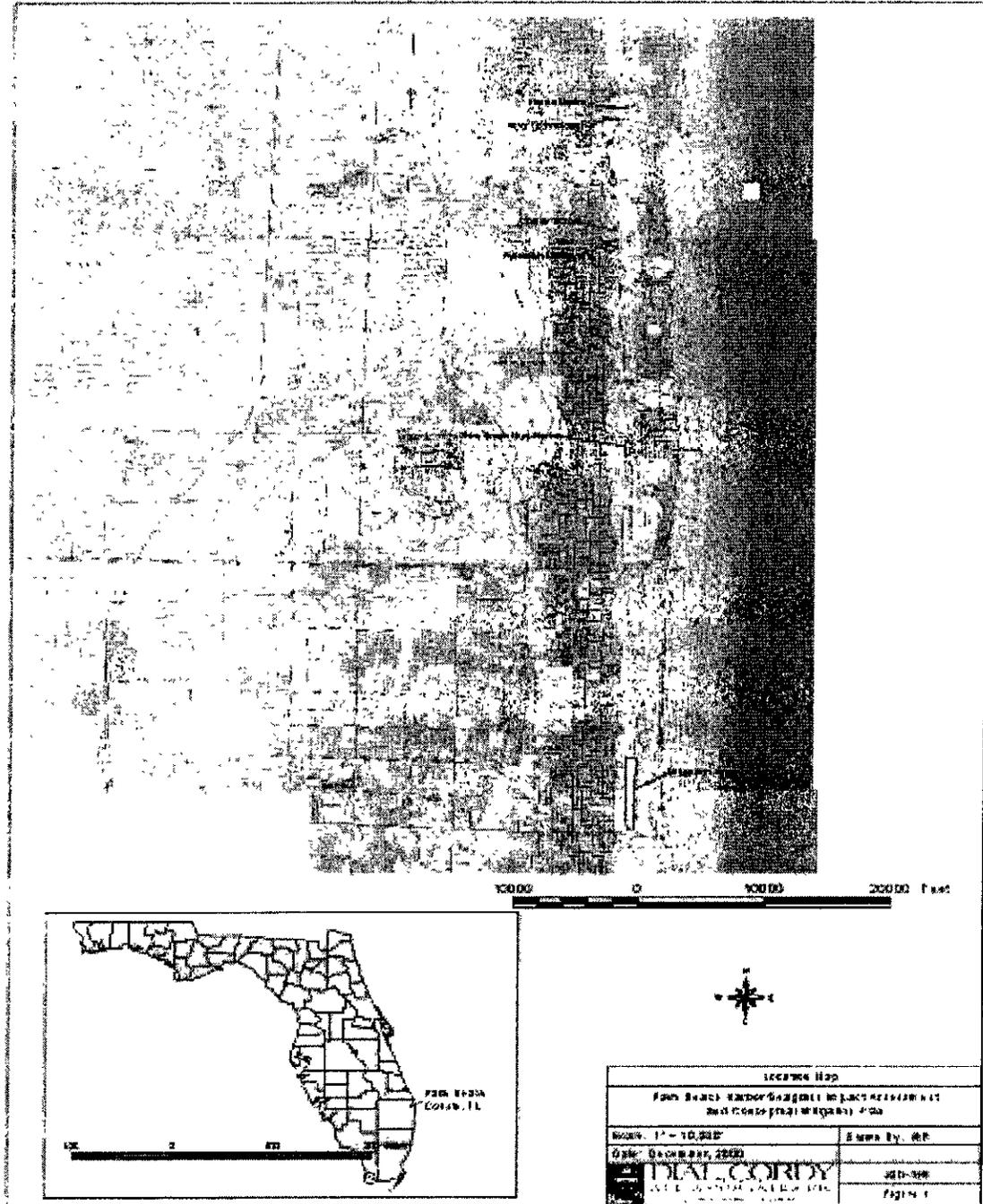
1.0 INTRODUCTION

Dial Cordy and Associates Inc. (Dial Cordy) was contracted by the Jacksonville District Corps of Engineers through Gulf Engineers & Consultants Inc. (GEC) contract (DACW17-99-D-0043) to assess the impact of dredging on marine seagrass habitat documented to occur at certain locations in Palm Beach County (Figure 1). The area of proposed dredging includes the AIWW and selected access channels and marina basins located between Florida Marine and Palm Beach Municipal Marina to the south in Palm Beach County. In addition, this report includes a conceptual mitigation plan as compensation for unavoidable impacts to seagrass habitat. Baseline seagrass surveys for the project area were previously completed (Dial Cordy 1999, 2000). A Biological Assessment for impacts to *H. johnsonii* was prepared for Section 7 coordination and is provided under separate cover.

1.1 Purpose

The objective of this report is to document the direct and indirect impacts of proposed dredging on marine seagrass resources known to occur in the AIWW and selected channels and basins adjacent to the AIWW where dredging is proposed. Specifically, this report assesses the direct loss and indirect impact of dredging on *Halophila johnsonii* (Johnson's grass), *H. decipiens* (Paddle grass), *Halodule wrightii* (Cuban shoal grass), *Thalassia testudinum* (Turtle grass), and *Syringodium filiforme* (Manatee grass) in the AIWW and six access channels and marina basins/facilities from Florida Marine north of the Port of Palm Beach to the Palm Beach Marina. Due to the protection afforded to *H. johnsonii* in 1998 by the listing of the species as a threatened marine plant, the 1999 designation by the NMFS of critical habitat for *H. johnsonii*, and of concerns by the NMFS for impacts to Essential Fish Habitat pursuant to the Manguson Stevens Fishery Conservation and Management Act (16 U.S.C. 1801-1882), an assessment of impacts on *H. johnsonii* and other seagrass species is required.

Figure 1 Location Map



1.2 Background

Recent efforts to document the distribution and occurrence of marine seagrass within Palm Beach County, including specifically the areas assessed for this project, have included a survey of marine seagrass communities within six access channels and marina basins (Dial Cordy and Associates Inc. 2000), a comprehensive survey of seagrass habitat within the federal AIWW channel from Hobe Sound through South Lake Worth Inlet (Dial Cordy and Associates Inc. 1999), and a video survey of marine seagrass within the AIWW of Palm Beach County by the Jacksonville District, Corps of Engineers (Lotspeich and Associates, Inc. 1998). Additional studies or surveys available include a summary of *H. johnsonii* occurrences in South Florida (PBS&J, in progress), and a Natural Resource Inventory of the Lake Worth shoals (Palm Beach County Department of Environmental Resource Management 1990). Other studies or surveys specifically on *H. johnsonii* include intensive surveys in Jupiter and Hobe Sound, and near Fort Pierce Inlet (Kenworthy 1993; Gallegos and Kenworthy 1996); an analysis of growth dynamics of the species (Bolen 1997); and unpublished data collected by the Department of Environmental Protection (FDEP) at potential marina sites along the AIWW (FDEP 1997).

2.0 TECHNICAL APPROACH

A description of analysis techniques and assumptions are presented in this section

2.1 Impact Analysis

For purposes of the impact analysis the following assumptions were made based on field observations (Dial Cordy 1999, 2000):

- Seagrass will not naturally recolonize following dredging below 12 feet MSL between the Port of Palm Beach and Florida Marine.

- Seagrass will not naturally recolonize following dredging below 10 feet MSL south of the Port of Palm Beach.
- Side slopes of the AIWW channel on the average have a 1:3 slope ratio (rise over run).
- Side slopes of the access channels and marina basins were based on existing bathymetric contours.
- Direct or permanent impacts include the area of seagrass located on the channel bottom and areas of the side slope below the above stated depths.
- Temporary or indirect impacts include the area of the side slopes where recolonization will occur following resettlement after dredging or in less than 12 feet MSL within channels north of the harbor.
- Channel side slopes will average a 1:3 slope following dredging.
- Area of impact for each seagrass cover type was determined by calculating the polygon cover area and multiplying this area by the average frequency of occurrence calculated from quadrat data (Dial Cordy 1999, 2000).

With these assumptions in mind a model was developed to determine the direct (permanent) and indirect (temporary) impacts for incremental dredging depths 12, 14, 16, and 17 feet below MSL, referred to as Projects 10, 12, 14, and 15 in the following results.

2.2 Conceptual Mitigation Plan

Development of the conceptual mitigation plan included an assessment of the existing site conditions at the mitigation area, including seagrass present (Dial Cordy 2000), depths, an evaluation of the feasibility of restoring shallow water habitat suitable for the propagation of seagrass species. Restoration methods most suitable for the site were analyzed, including disposal of dredged material to raise the bottom depths to the photic zone and planting of seagrass species from donor material in the proposed dredged areas.

3.0 IMPACT ASSESSMENT

A summary of direct (permanent) and indirect (temporary) impacts for the main federal portion of the AIWW channel (Cut 35, through Cut 36, 97+13), Florida Inland Navigation District section of the AIWW (Cut 36, 97+13 through Cut 41, 7+50), and all facilities (access channels and basins) are presented in Table 1. More detailed results of the seagrass impact analysis for incremental depths are provided in Tables 2-5. Figure 2 illustrates the locations where impacts to seagrass communities will occur. Locations of seagrass impacts within the federal channel are not depicted in Figure 1 due to the wide distance between survey transects (250 ft). Impacts were extrapolated based on belt transect and quadrat data (Dial Cordy and Associates Inc. 1999).

The estimated total permanent and temporary impacts to seagrass for Projects 10, 12, 14, and 15 are 14.81 acres, 2.20 acres; 16.33 acres, 2.62 acres; 18.11 acres, 2.77 acres; and 18.59 acres, 2.82 acres, respectively. With an increased dredging depth of 5 feet (Projects 10 to 15), the total impacts increase from 17.01 acres to 21.39 acres, which implies an average increase in impacts of 0.88 acre per foot dredged. Total impacts (permanent and temporary) to *H. johnsonii* ranged from 4.53 acres for Project 10 (depth 12 feet) to 5.57 acre for Project 15 (depth 17 feet). The projected average incremental increase in impact to *H. johnsonii* is 0.21 acre per foot of dredging depth. A review of project impacts for each area is provided below.

3.1 Federal Channel

This section of the AIWW includes the area proposed by the Corps of Engineers for dredging from south of the Blue Heron Bridge to Cut 36, 97+13 and the area under FIND authority further south from Cut 36, 97+13 to Cut 41, 7+50 (Tables 2-5, Figure 2). A description of the incremental project impacts is summarized in the following sub-sections.

Table 1 Seagrass Impacts for Federal Channel, FIND Channel, and Marine Facilities

	Project 10			Project 12			Project 14			Project 15		
	Perm	Temp	Total									
FEDERAL PORTION OF AIWW												
Total <i>H. johnsonii</i> communities	1.62	0.35	1.97	1.83	0.48	2.31	2.11	0.53	2.64	2.17	0.52	2.69
Other seagrass communities	6.59	0.68	7.27	7.41	0.82	8.23	8.42	0.86	9.28	8.71	0.82	9.51
Total seagrass	8.21	1.03	9.24	9.24	1.30	10.54	10.53	1.39	11.92	10.88	1.34	12.20
FIND PORTION OF AIWW												
Total <i>H. johnsonii</i> communities	1.10	0.02	1.12	1.10	0.03	1.13	1.10	0.03	1.13	1.10	0.03	1.13
Other seagrass communities	0.91	0.02	0.93	0.98	0.04	1.02	1.10	0.04	1.14	1.11	0.05	1.16
Total seagrass	2.01	0.04	2.05	2.08	0.07	2.15	2.20	0.07	2.27	2.21	0.08	2.29
MARINE FACILITIES (Access Channel and Basin)												
Total <i>H. johnsonii</i> communities	1.07	0.38	1.45	1.22	0.34	1.56	1.34	0.36	1.70	1.39	0.37	1.76
Other seagrass communities	3.52	0.75	4.27	3.79	0.91	4.70	4.04	0.95	4.99	4.11	1.03	5.14
Total seagrass	4.59	1.13	5.72	5.01	1.25	6.26	5.38	1.31	6.69	5.50	1.40	6.90
Total Project - <i>H. johnsonii</i>	3.79	0.75	4.54	4.15	0.85	5.00	4.55	0.92	5.47	4.66	0.92	5.58
Total Project - Seagrass	14.81	2.20	17.01	16.33	2.62	18.95	18.11	2.77	20.88	18.59	2.82	21.39

Table 2 Project 10-Dredging Impacts on Seagrass Communities, Palm Beach County, FL

Seagrass Cover Class	Channel Perm (sq ft)	1:3 Slope Perm (sq ft)	1:3 Slope Temp (sq ft)	Total Perm (sq ft)	Total Area Impact (sq ft)	Est Impact (ac)	
						Perm	Total
Florida Marine							
HJ - Halophilla johnsonii	0	0	0	0	0	0.00	0.00
HD - Halophilla decipens	21740	0	6340	21740	28080	0.50	0.64
HW - Halodule wrightii	0	0	0	0	0	0.00	0.00
TT - Thalassia testudium	12403	0	1549	12403	13952	0.28	0.32
SF - Syringodium filiforme	0	0	0	0	0	0.00	0.00
HJ w/ HD,HW	8202	0	1242	8202	9444	0.19	0.22
HJ w/ SF,TT	0	0	0	0	0	0.00	0.00
HD/TT	13520	0	3398	13520	16918	0.31	0.39
Mixed Seagrass w/o HJ	14520	0	9538	14520	24058	0.33	0.55
Total HJ Communities	8202	0	1242	8202	9444	0.19	0.22
Facility Total	70385	0	22067	70385	92452	1.62	2.12
Perry Technologies							
HJ - Halophilla johnsonii	0	0	0	0	0	0.00	0.00
HD - Halophilla decipens	41722	0	4135	41722	45857	0.96	1.05
HW - Halodule wrightii	113	0	1093	113	1206	0.00	0.03
TT - Thalassia testudium	0	0	0	0	0	0.00	0.00
SF - Syringodium filiforme	0	0	0	0	0	0.00	0.00
HJ w/ HD,HW	4557	0	3010	4557	7567	0.10	0.17
HJ w/ SF,TT	0	0	0	0	0	0.00	0.00
HD/TT	12453	0	1584	12453	14037	0.29	0.32
Mixed Seagrass w/o HJ	36	0	1184	36	1220	0.00	0.03
Total HJ Communities	4557	0	3010	4557	7567	0.10	0.17
Facility Total	58881	0	11006	58881	69887	1.35	1.60
Charter School							
HJ - Halophilla johnsonii	6268	832	2449	7100	9549	0.16	0.22
HD - Halophilla decipens	0	1	13	1	14	0.00	0.00
HW - Halodule wrightii	0	0	0	0	0	0.00	0.00
TT - Thalassia testudium	9196	162	177	9358	9535	0.21	0.22
SF - Syringodium filiforme	0	0	0	0	0	0.00	0.00
HJ w/ HD,HW	18643	2342	7006	20985	27991	0.48	0.64
HJ w/ SF,TT	0	0	0	0	0	0.00	0.00
HD/TT	3177	283	636	3460	4096	0.08	0.09
Mixed Seagrass w/o HJ	0	0	0	0	0	0.00	0.00
Total HJ Communities	24911	3174	9455	28085	37540	0.64	0.86
Facility Total	37284	3620	10281	40904	51185	0.94	1.18
Rybovitch Marina							
HJ - Halophilla johnsonii	2377	358	578	2735	3313	0.06	0.08
HD - Halophilla decipens	7494	704	943	8198	9141	0.19	0.21
HW - Halodule wrightii	0	0	0	0	0	0.00	0.00
TT - Thalassia testudium	11618	986	1709	12604	14313	0.29	0.33
SF - Syringodium filiforme	0	0	0	0	0	0.00	0.00
HJ w/ HD,HW	2644	518	1658	3162	4820	0.07	0.11
HJ w/ SF,TT	316	55	127	371	498	0.01	0.01
HD/TT	2152	532	1162	2684	3846	0.06	0.09
Mixed Seagrass w/o HJ	0	0	0	0	0	0.00	0.00
Total HJ Communities	5337	931	2363	6268	8631	0.14	0.20

Seagrass Cover Class	Channel Perm (sq ft)	1:3 Slope Perm (sq ft)	1:3 Slope Temp (sq ft)	Total Perm (sq ft)	Total Area Impact (sq ft)	Est Impact (ac)	
						Perm	Total
Facility Total	26601	3153	6177	29754	35931	0.68	0.82
Main Channel North of Turning Basin (Cut 35, 0+00 thru Cut 36, 7+50)							
HJ - Halophyllia johnsonii	0	0	864	0	864	0.00	0.02
HD - Halophyllia decipens	187177	0	23928	187177	211105	4.30	4.85
HJ w/ HD,HW	2136	0	5397	2136	7534	0.05	0.17
HW	0	0	3238	0	3238	0.00	0.07
Total HJ Communities	2136	0	6261	2136	8397	0.05	0.19
Area Total	189313	0	33427	189313	222740	4.35	5.11
Main Channel South of Turning Basin thru Rybovitch/Spencer (Cut 36, 30+00 thru Cut 36, 97+13)							
HJ - Halophyllia johnsonii	3390	886	1915	4277	6191	0.10	0.14
HD - Halophyllia decipens	83339	16577	2708	99917	102624	2.29	2.36
HJ w/ HD,HW	58667	5434	7002	64101	71102	1.47	1.63
HW	0	0	0	0	0	0.00	0.00
Total HJ Communities	62057	6320	8916	68377	77294	1.57	1.77
Area Total	145396	22898	11624	168294	179918	3.86	4.13
Main Channel - Federal Channel Portion (Cut 35, 0+00 thru Cut 36, 97+13)							
HJ - Halophyllia johnsonii	3390	886	2778	4277	7055	0.10	0.16
HD - Halophyllia decipens	270516	16577	26636	287093	313729	6.59	7.20
HJ w/ HD,HW	60803	5434	12399	66237	78636	1.52	1.81
HW	0	0	3238	0	3238	0.00	0.07
Total HJ Communities	64193	6320	15177	70513	85691	1.62	1.97
Area Total	334709	22898	45052	357607	402658	8.21	9.24
Main Channel - F.I.N.D. Portion (Cut 36, 97+13 thru Cut 41, 7+50)							
HJ - Halophyllia johnsonii	9465	0	0	9465	9465	0.22	0.22
HD - Halophyllia decipens	36959	2763	1147	39722	40868	0.91	0.94
HJ w/ HD,HW	38537	0	625	38537	39162	0.88	0.90
HW	0	0	0	0	0	0.00	0.00
Total HJ Communities	48002	0	625	48002	48627	1.10	1.12
Area Total	84961	2763	1772	87724	89496	2.01	2.05
Comprehensive Main Channel - Florida Marine thru F.I.N.D. (Cut 35, 0+00 thru Cut 41, 7+50)							
HJ - Halophyllia johnsonii	12855	886	2778	13742	16520	0.32	0.38
HD - Halophyllia decipens	307475	19340	27783	326815	354597	7.50	8.14
HJ w/ HD,HW	99340	5434	13025	104774	117798	2.41	2.70
HW	0	0	3238	0	3238	0.00	0.07
Total HJ Communities	112195	6320	15803	118515	134318	2.72	3.08
Area Total	419670	25660	46824	445330	492154	10.22	11.30

Overall Project Area Summary - All Facilities and Main Channel (Cut 35, 0+00 thru Cut 41, 7+50)

Seagrass Cover Class	Channel Perm (sqft)	1:3 Slope Perm (sqft)	1:3 Slope Temp (sqft)	Total Perm (sqft)	Total Area Impact (sqft.)	Est. Impact (ac.)	
						Perm	Total
HJ - Halophilla johnsonii	21500	2076	5805	23577	29382	0.54	0.87
HD - Halophilla decipens	378431	20045	39214	398476	437689	9.15	10.05
HW - Halodule wrightii	113	0	4331	113	4444	0.00	0.10
TT - Thalassia testudium	33217	1148	3435	34365	37800	0.79	0.87
SF - Syringodium filiforme	0	0	0	0	0	0.00	0.00
HJ w/ HD,HW	133386	8294	25941	141680	167620	3.25	3.85
HJ w/ SF,TT	316	55	127	371	498	0.01	0.01
HD/TT	31302	815	6780	32117	38897	0.74	0.89
Mixed Seagrass w/o HJ	14556	0	10722	14556	25278	0.33	0.58
Total HJ Communities	155202	10425	31873	165627	197500	3.80	4.53
Project Area Total	612821	32433	96355	645254	741609	14.81	17.02

Table 3 Project 12-Dredging Impacts on Seagrass Communities, Palm Beach County, FL

Seagrass Cover Class	Channel Perm (sqft)	1:3 Slope Perm (sqft)	1:3 Slope Temp (sqft)	Total Perm (sqft)	Total Area Impact (sqft.)	Est. Impact (ac.)	
						Perm	Total
Florida Marine							
HJ - Halophillia johnsonii	0	0	0	0	0	0.00	0.00
HD - Halophillia decipens	21740	2757	7516	24497	32013	0.56	0.73
HW - Halodule wrightii	0	0	0	0	0	0.00	0.00
TT - Thalassia testudium	12403	618	1371	13021	14392	0.30	0.33
SF - Syringodium filiforme	0	0	0	0	0	0.00	0.00
HJ w/ HD,HW	8202	781	583	8983	9566	0.21	0.22
HJ w/ SF,TT	0	0	0	0	0	0.00	0.00
HD/TT	13520	1060	3622	14580	18202	0.33	0.42
Mixed Seagrass w/o HJ	14520	2380	13781	16900	30681	0.39	0.70
Total HJ Communities	8202	781	583	8983	9566	0.21	0.22
Facility Total	70385	7596	26873	77981	104854	1.79	2.41
Perry Technologies							
HJ - Halophillia johnsonii	0	0	0	0	0	0.00	0.00
HD - Halophillia decipens	41722	1635	4260	43357	47617	1.00	1.09
HW - Halodule wrightii	113	0	2172	113	2285	0.00	0.05
TT - Thalassia testudium	0	0	0	0	0	0.00	0.00
SF - Syringodium filiforme	0	0	0	0	0	0.00	0.00
HJ w/ HD,HW	4557	1146	3093	5703	8796	0.13	0.20
HJ w/ SF,TT	0	0	0	0	0	0.00	0.00
HD/TT	12453	947	1294	13400	14694	0.31	0.34
Mixed Seagrass w/o HJ	36	165	1538	201	1739	0.00	0.04
Total HJ Communities	4557	1146	3093	5703	8796	0.13	0.20
Facility Total	58881	3893	12357	62774	75131	1.44	1.72
Charter School							
HJ - Halophillia johnsonii	6268	1625	2381	7893	10274	0.18	0.24
HD - Halophillia decipens	0	6	19	6	25	0.00	0.00
HW - Halodule wrightii	0	0	0	0	0	0.00	0.00
TT - Thalassia testudium	9196	341	69	9537	9806	0.22	0.22
SF - Syringodium filiforme	0	0	0	0	0	0.00	0.00
HJ w/ HD,HW	18643	4618	6703	23261	29964	0.53	0.69
HJ w/ SF,TT	0	0	16	0	16	0.00	0.00
HD/TT	3177	538	493	3715	4208	0.09	0.10
Mixed Seagrass w/o HJ	0	0	0	0	0	0.00	0.00
Total HJ Communities	24911	6243	9100	31154	40254	0.72	0.92
Facility Total	37284	7128	9681	44412	54093	1.02	1.24
Rybovitch Marina							
HJ - Halophillia johnsonii	2377	623	425	3000	3425	0.07	0.08
HD - Halophillia decipens	7494	1489	617	8983	9600	0.21	0.22
HW - Halodule wrightii	0	0	0	0	0	0.00	0.00
TT - Thalassia testudium	11618	1926	1513	13544	15057	0.31	0.35
SF - Syringodium filiforme	0	0	0	0	0	0.00	0.00
HJ w/ HD,HW	2644	1050	2072	3694	5766	0.08	0.13
HJ w/ SF,TT	316	116	146	432	578	0.01	0.01
HD/TT	2152	1182	1110	3334	4444	0.08	0.10
Mixed Seagrass w/o HJ	0	0	0	0	0	0.00	0.00
Total HJ Communities	5337	1789	2643	7126	9769	0.16	0.22

Seagrass Cover Class	Channel Perm (sqft)	1:3 Slope Perm (sqft)	1:3 Slope Temp (sqft)	Total Perm (sqft)	Total Area Impact (sqft.)	Est. Impact (ac.)	
						Perm	Total
Facility Total	26601	6386	5883	32987	38870	0.76	0.89
Main Channel North of Turning Basin (Cut 35, 0+00 thru Cut 36, 7+50)							
HJ - Halophila johnsonii	0	509	1005	509	1514	0.01	0.03
HD - Halophila decipens	187177	17829	27846	205005	232851	4.71	5.35
HJ w/ HD,HW	2136	1783	6281	3919	10200	0.09	0.23
HW	0	0	3769	0	3769	0.00	0.09
Total HJ Communities	2136	2292	7286	4428	11714	0.10	0.27
Area Total	189313	20121	38900	209434	248334	4.81	5.70
Main Channel South of Turning Basin thru Rybovitch/Spencer (Cut 36, 30+00 thru Cut 36, 97+13)							
HJ - Halophila johnsonii	3390	1850	2907	5240	8147	0.12	0.19
HD - Halophila decipens	83339	34605	4111	117944	122056	2.71	2.80
HJ w/ HD,HW	58667	11343	10631	70010	80641	1.61	1.85
HW	0	0	0	0	0	0.00	0.00
Total HJ Communities	62057	13193	13538	75250	88788	1.73	2.04
Area Total	145396	47798	17649	193195	210844	4.44	4.84
Main Channel - Federal Channel Portion (Cut 35, 0+00 thru Cut 36, 97+13)							
HJ - Halophila johnsonii	3390	2360	3912	5750	9662	0.13	0.22
HD - Halophila decipens	270516	52434	31957	322950	354907	7.41	8.15
HJ w/ HD,HW	60803	13126	16912	73929	90841	1.70	2.09
HW	0	0	3769	0	3769	0.00	0.09
Total HJ Communities	64193	15486	20824	79679	100503	1.83	2.31
Area Total	334709	67919	56550	402628	459178	9.24	10.54
Main Channel - F.I.N.D. Portion (Cut 36, 97+13 thru Cut 41, 7+50)							
HJ - Halophila johnsonii	9465	0	0	9465	9465	0.22	0.22
HD - Halophila decipens	36959	5820	1851	42779	44629	0.98	1.02
HJ w/ HD,HW	38537	0	1009	38537	39546	0.88	0.91
HW	0	0	0	0	0	0.00	0.00
Total HJ Communities	48002	0	1009	48002	49011	1.10	1.13
Area Total	84961	5820	2860	90781	93641	2.08	2.15
Comprehensive Main Channel - Florida Marine thru F.I.N.D. (Cut 35, 0+00 thru Cut 41, 7+50)							
HJ - Halophila johnsonii	12855	2360	3912	15215	19127	0.35	0.44
HD - Halophila decipens	307475	58253	33808	365728	399536	8.40	9.17
HJ w/ HD,HW	99340	13126	17922	112466	130387	2.58	2.99
HW	0	0	3769	0	3769	0.00	0.09
Total HJ Communities	112195	15486	21834	127681	149514	2.93	3.43
Area Total	419670	73739	59410	493409	552819	11.33	12.69

Overall Project Area Summary - All Facilities and Main Channel (Cut 35, 0+00 thru Cut 41, 7+50)

Seagrass Cover Class	Channel Perm (sqft)	1:3 Slope Perm (sqft)	1:3 Slope Temp (sqft)	Total Perm (sqft)	Total Area Impact (sqft.)	Est. Impact (ac.)	
						Perm	Total
HJ - Halophila johnsonii	21500	4608	6718	28108	32826	0.60	0.75
HD - Halophila decipens	378431	64140	46220	442571	488791	10.16	11.22
HW - Halodule wrightii	113	0	5941	113	6054	0.00	0.14
TT - Thalassia testudium	33217	2885	2953	36102	39055	0.83	0.90
SF - Syringodium filiforme	0	0	0	0	0	0.00	0.00
HJ w/ HD,HW	133386	20721	30373	154107	184479	3.54	4.24
HJ w/ SF,TT	316	116	162	432	594	0.01	0.01
HD/TT	31302	3727	6519	35029	41548	0.80	0.95
Mixed Seagrass w/o HJ	14556	2545	15319	17101	32420	0.39	0.74
Total HJ Communities	155202	25446	37253	180647	217899	4.15	5.00
Project Area Total	612821	98742	114204	711563	825767	16.34	18.96

Table 4. Project 14-Dredging Impacts on Seagrass Communities, Palm Beach County, FL

Seagrass Cover Class	Channel Perm (sqft)	1:3 Slope Perm (sqft)	Slope Temp (sqft)	Total Perm (sqft)	Total Area Impact (sqft.)	Est. Impact (ac.)	
						Perm	Total
Florida Marine							
HJ - Halophyllia johnsonii	0	0	0	0	0	0.00	0.00
HD - Halophyllia decipens	21740	4438	7885	26178	34063	0.60	0.78
HW - Halodule wrightii	0	0	11	0	11	0.00	0.00
TT - Thalassia testudium	12403	869	1533	13272	14805	0.30	0.34
SF - Syringodium filiforme	0	0	0	0	0	0.00	0.00
HJ w/ HD,HW	8202	1169	272	9371	9643	0.22	0.22
HJ w/ SF,TT	0	0	0	0	0	0.00	0.00
HD/TT	13520	1771	3675	15291	18966	0.35	0.44
Mixed Seagrass w/o HJ	14520	5333	13685	19853	33538	0.46	0.77
Total HJ Communities	8202	1169	272	9371	9643	0.22	0.22
Facility Total	70385	13580	27061	83965	111026	1.93	2.55
Perry Technologies							
HJ - Halophyllia johnsonii	0	0	0	0	0	0.00	0.00
HD - Halophyllia decipens	41722	2758	4805	44480	49285	1.02	1.13
HW - Halodule wrightii	113	0	3522	113	3635	0.00	0.08
TT - Thalassia testudium	0	0	0	0	0	0.00	0.00
SF - Syringodium filiforme	0	0	0	0	0	0.00	0.00
HJ w/ HD,HW	4557	2786	2566	7343	9909	0.17	0.23
HJ w/ SF,TT	0	0	0	0	0	0.00	0.00
HD/TT	12453	1814	865	14267	15132	0.33	0.35
Mixed Seagrass w/o HJ	36	649	1970	685	2655	0.02	0.06
Total HJ Communities	4557	2786	2566	7343	9909	0.17	0.23
Facility Total	58881	8007	13728	66888	80616	1.54	1.85
Charter School							
HJ - Halophyllia johnsonii	6268	2404	2162	8672	10834	0.20	0.25
HD - Halophyllia decipens	0	14	39	14	53	0.00	0.00
HW - Halodule wrightii	0	0	0	0	0	0.00	0.00
TT - Thalassia testudium	9196	539	144	9735	9879	0.22	0.23
SF - Syringodium filiforme	0	0	0	0	0	0.00	0.00
HJ w/ HD,HW	18643	6424	7019	25067	32086	0.58	0.74
HJ w/ SF,TT	0	0	168	0	168	0.00	0.00
HD/TT	3177	934	361	4111	4472	0.09	0.10
Mixed Seagrass w/o HJ	0	0	0	0	0	0.00	0.00
Total HJ Communities	24911	8828	9349	33739	43088	0.77	0.99
Facility Total	37284	10315	9893	47599	57492	1.09	1.32
Rybovitch Marina							
HJ - Halophyllia johnsonii	2377	823	254	3200	3454	0.07	0.08
HD - Halophyllia decipens	7494	1927	856	9421	10277	0.22	0.24
HW - Halodule wrightii	0	0	0	0	0	0.00	0.00
TT - Thalassia testudium	11618	2587	1412	14205	15617	0.33	0.36
SF - Syringodium filiforme	0	0	0	0	0	0.00	0.00
HJ w/ HD,HW	2644	1685	2652	4329	6981	0.10	0.16
HJ w/ SF,TT	316	173	216	489	705	0.01	0.02
HD/TT	2152	1932	954	4084	5038	0.09	0.12

Seagrass Cover Class	Channel Perm (sqft)	1:3 Slope Perm (sqft)	Slope Temp (sqft)	Total Perm (sqft)	Total Area Impact (sqft.)	Est. Impact (ac.)	
						Perm	Total
Mixed Seagrass w/o HJ	0	0	0	0	0	0.00	0.00
Total HJ Communities	5337	2681	3122	8018	11140	0.18	0.26
Facility Total	26601	9127	6344	35728	42072	0.82	0.97
Main Channel North of Turning Basin (Cut 35, 0+00 thru Cut 36, 7+50)							
HJ - Halophilla johnsonii	0	997	1051	997	2048	0.02	0.05
HD - Halophilla decipens	187177	34908	29125	222084	251209	5.10	5.77
HJ w/ HD,HW	2136	3491	6568	5627	12196	0.13	0.28
HW	0	0	3942	0	3942	0.00	0.09
Total HJ Communities	2136	4488	7621	6624	14245	0.15	0.33
Area Total	189313	39396	40687	228708	269395	5.25	6.18
Main Channel South of Turning Basin thru Rybovitch/Spencer (Cut 36, 30+00 thru Cut 36, 97+13)							
HJ - Halophilla johnsonii	3390	3271	3304	6661	9964	0.15	0.23
HD - Halophilla decipens	83339	61163	4673	144503	149175	3.32	3.42
HJ w/ HD,HW	58667	20048	12082	78715	90797	1.81	2.08
HW	0	0	0	0	0	0.00	0.00
Total HJ Communities	62057	23319	15386	85376	100762	1.96	2.31
Area Total	145396	84482	20059	229878	249937	5.28	5.74
Main Channel - Federal Channel Portion (Cut 35, 0+00 thru Cut 36, 97+13)							
HJ - Halophilla johnsonii	3390	4268	4355	7658	12013	0.18	0.28
HD - Halophilla decipens	270516	96071	33797	366587	400384	8.42	9.19
HJ w/ HD,HW	60803	23539	18652	84342	102994	1.94	2.36
HW	0	0	3942	0	3942	0.00	0.09
Total HJ Communities	64193	27807	23007	92000	115007	2.11	2.64
Area Total	334709	123878	60746	458587	519332	10.53	11.92
Main Channel - F.I.N.D. Portion (Cut 36, 97+13 thru Cut 41, 7+50)							
HJ - Halophilla johnsonii	9465	0	0	9465	9465	0.22	0.22
HD - Halophilla decipens	36959	10698	2108	47657	49765	1.09	1.14
HJ w/ HD,HW	38537	0	1150	38537	39686	0.88	0.91
HW	0	0	0	0	0	0.00	0.00
Total HJ Communities	48002	0	1150	48002	49152	1.10	1.13
Area Total	84961	10698	3258	95659	98917	2.20	2.27
Comprehensive Main Channel - Florida Marine thru F.I.N.D. (Cut 35, 0+00 thru Cut 41, 7+50)							
HJ - Halophilla johnsonii	12855	4268	4355	17123	21478	0.39	0.49
HD - Halophilla decipens	307475	106769	35905	414244	450149	9.51	10.33
HJ w/ HD,HW	99340	23539	19802	122879	142680	2.82	3.28
HW	0	0	3942	0	3942	0.00	0.09
Total HJ Communities	112195	27807	24157	140002	164158	3.21	3.77
Area Total	419670	134576	64003	554246	618249	12.72	14.19

Overall Project Area Summary - All Facilities and Main Channel (Cut 35, 0+00 thru Cut 41, 7+50)

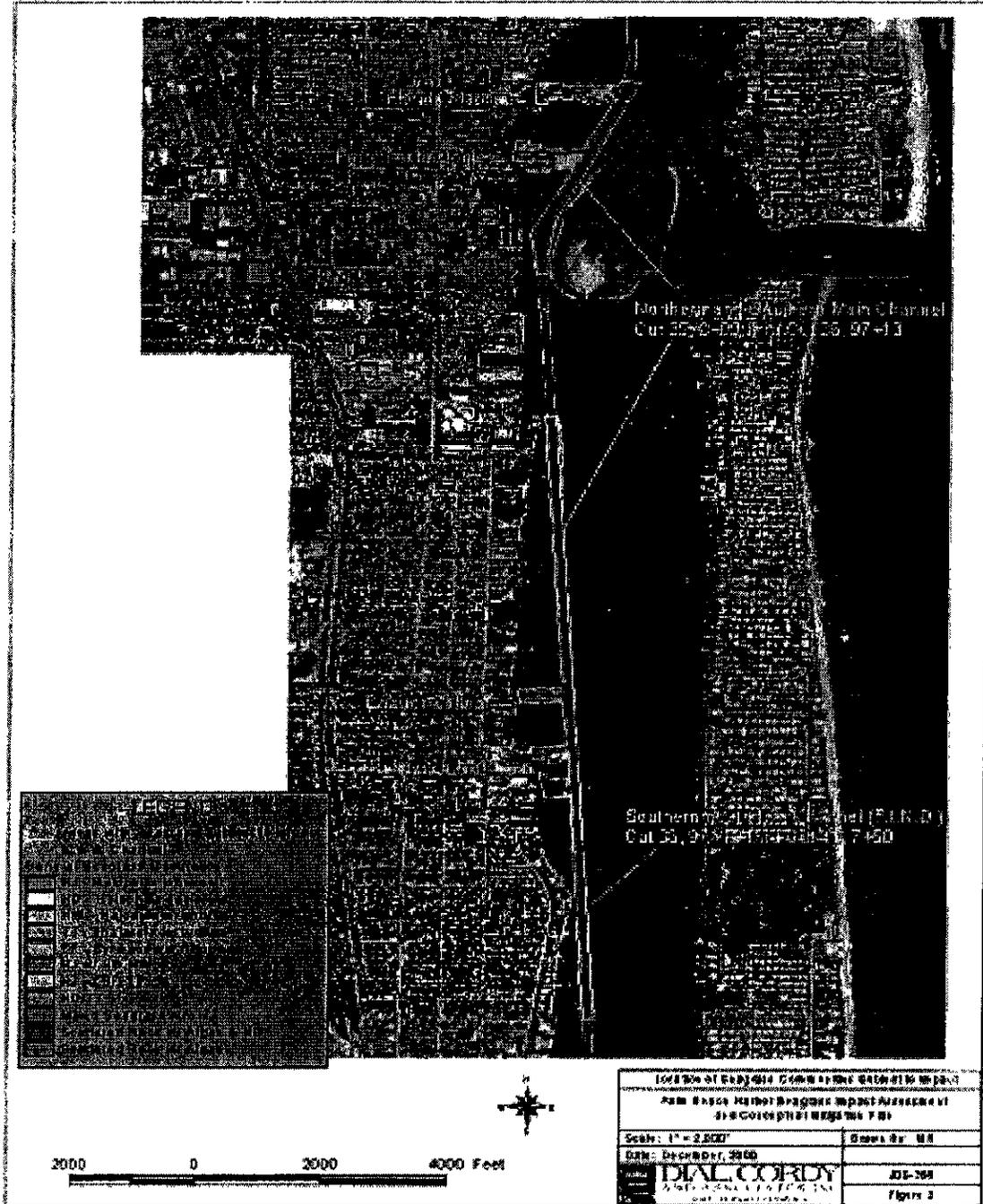
Seagrass	Channel	1:3 Slope	1:3 Slope	Total	Total Area		Est. Impact (ac.)
Cover Class	Perm (sqft)	Perm (sqft)	Temp (sqft)	Perm (sqft)	Impact (sqft.)	Perm	Total
HJ - Halophyllia johnsonii	21500	7495	6771	28995	35766	0.67	0.82
HD - Halophyllia decipens	378431	115906	49490	494337	543827	11.35	12.48
HW - Halodule wrightii	113	0	7475	113	7588	0.00	0.17
TT - Thalassia testudium	33217	3995	3089	37212	40301	0.85	0.93
SF - Syringodium filiforme	0	0	0	0	0	0.00	0.00
HJ w/ HD,HW	133386	35603	32311	168989	201299	3.88	4.62
HJ w/ SF,TT	316	173	384	489	873	0.01	0.02
HD/TT	31302	6451	5855	37753	43608	0.87	1.00
Mixed Seagrass w/o HJ	14556	5982	15655	20538	36193	0.47	0.83
Total HJ Communities	155202	43271	39466	198473	237938	4.56	5.46
Project Area Total	612821	175605	121029	788426	909455	18.10	20.88

Table 5 Project 15-Dredging Impacts on Seagrass Communities, Palm Beach County, FL

Seagrass Cover Class	Channel Perm (sq ft)	1:3 Slope Perm (sq ft)	1:3 Slope Temp (sq ft)	Total Perm (sq ft)	Total Area Impact (sq ft)	Est Impact (ac)	
						Perm	Total
Florida Marine							
HJ - Halophilla johnsonii	0	0	0	0	0	0.00	0.00
HD - Halophilla decipens	21740	5160	8900	26900	35800	0.62	0.82
HW - Halodule wrightii	0	0	159	0	159	0.00	0.00
TT - Thalassia testudium	12403	1003	1882	13406	15288	0.31	0.35
SF - Syringodium filiforme	0	0	0	0	0	0.00	0.00
HJ w/ HD,HW	8202	1242	376	9444	9820	0.22	0.23
HJ w/ SF,TT	0	0	0	0	0	0.00	0.00
HD/TT	13520	1955	4069	15475	19544	0.36	0.45
Mixed Seagrass w/o HJ	14520	5800	15327	20320	35647	0.47	0.82
Total HJ Communities	8202	1242	376	9444	9820	0.22	0.23
Facility Total	70385	15160	30713	85545	116258	1.96	2.67
Perry Technologies							
HJ - Halophilla johnsonii	0	0	0	0	0	0.00	0.00
HD - Halophilla decipens	41722	3238	4752	44960	49712	1.03	1.14
HW - Halodule wrightii	113	0	4359	113	4472	0.00	0.10
TT - Thalassia testudium	0	0	0	0	0	0.00	0.00
SF - Syringodium filiforme	0	0	0	0	0	0.00	0.00
HJ w/ HD,HW	4557	2786	3374	7343	10717	0.17	0.25
HJ w/ SF,TT	0	0	0	0	0	0.00	0.00
HD/TT	12453	1814	1008	14267	15275	0.33	0.35
Mixed Seagrass w/o HJ	36	649	1970	685	2655	0.02	0.06
Total HJ Communities	4557	2786	3374	7343	10717	0.17	0.25
Facility Total	58881	8487	15463	67368	82831	1.55	1.90
Charter School							
HJ - Halophilla johnsonii	6268	2844	1837	9112	10949	0.21	0.25
HD - Halophilla decipens	0	20	44	20	64	0.00	0.00
HW - Halodule wrightii	0	0	0	0	0	0.00	0.00
TT - Thalassia testudium	9196	620	90	9816	9906	0.23	0.23
SF - Syringodium filiforme	0	0	0	0	0	0.00	0.00
HJ w/ HD,HW	18643	7435	6755	26078	32833	0.60	0.75
HJ w/ SF,TT	0	0	242	0	242	0.00	0.01
HD/TT	3177	1080	244	4257	4501	0.10	0.10
Mixed Seagrass w/o HJ	0	0	0	0	0	0.00	0.00
Total HJ Communities	24911	10279	8834	35190	44024	0.81	1.01
Facility Total	37284	11999	9212	49283	58495	1.13	1.34
Rybovitch Marina							
HJ - Halophilla johnsonii	2377	904	172	3281	3453	0.08	0.08
HD - Halophilla decipens	7494	2372	644	9866	10510	0.23	0.24
HW - Halodule wrightii	0	0	0	0	0	0.00	0.00
TT - Thalassia testudium	11618	3023	1271	14641	15912	0.34	0.37
SF - Syringodium filiforme	0	0	0	0	0	0.00	0.00
HJ w/ HD,HW	2644	1978	2747	4622	7369	0.11	0.17
HJ w/ SF,TT	316	209	251	525	776	0.01	0.02
HD/TT	2152	2235	617	4387	5004	0.10	0.11
Mixed Seagrass w/o HJ	0	0	0	0	0	0.00	0.00
Total HJ Communities	5337	3091	3170	8428	11598	0.19	0.27
Facility Total	26601	10721	5702	37322	43024	0.86	0.99

Seagrass Cover Class	Channel Perm (sq ft)	1:3 Slope Perm (sq ft)	1:3 Slope Temp (sq ft)	Total Perm (sq ft)	Total Area Impact (sq ft)	Est Impact (ac)	
						Perm	Total
Main Channel North of Turning Basin (Cut 35, 0+00 thru Cut 36, 7+50)							
HJ - Halophillia johnsonii	0	1256	990	1256	2246	0.03	0.05
HD - Halophillia decipens	187177	43947	27432	231124	258556	5.31	5.94
HJ w/ HD,HW	2136	4395	6188	6531	12719	0.15	0.29
HW	0	0	3713	0	3713	0.00	0.09
Total HJ Communities	2136	5650	7178	7787	14964	0.18	0.34
Area Total	189313	49597	38323	238910	277233	5.48	6.36
Main Channel South of Turning Basin thru Rybovitch/Spencer (Cut 36, 30+00 thru Cut 36, 97+13)							
HJ - Halophillia johnsonii	3390	3441	3314	6831	10145	0.16	0.23
HD - Halophillia decipens	83339	64354	4687	147693	152380	3.39	3.50
HJ w/ HD,HW	58667	21094	12120	79761	91881	1.83	2.11
HW	0	0	0	0	0	0.00	0.00
Total HJ Communities	62057	24535	15434	86592	102026	1.99	2.34
Area Total	145396	88889	20121	234285	254406	5.38	5.84
Main Channel - Federal Channel Portion (Cut 35, 0+00 thru Cut 36, 97+13)							
HJ - Halophillia johnsonii	3390	4697	4304	8087	12391	0.19	0.28
HD - Halophillia decipens	270516	108301	32119	378817	410936	8.70	9.43
HJ w/ HD,HW	60803	25489	18308	86292	104599	1.98	2.40
HW	0	0	3713	0	3713	0.00	0.09
Total HJ Communities	64193	30185	22612	94379	116990	2.17	2.69
Area Total	334709	138486	58443	473195	531639	10.86	12.20
Main Channel - F.I.N.D. Portion (Cut 36, 97+13 thru Cut 41, 7+50)							
HJ - Halophillia johnsonii	9465	0	0	9465	9465	0.22	0.22
HD - Halophillia decipens	36959	11231	2360	48190	50549	1.11	1.16
HJ w/ HD,HW	38537	0	1287	38537	39824	0.88	0.91
HW	0	0	0	0	0	0.00	0.00
Total HJ Communities	48002	0	1287	48002	49289	1.10	1.13
Area Total	84961	11231	3647	96192	99838	2.21	2.29
Comprehensive Main Channel - Florida Marine thru F.I.N.D. (Cut 35, 0+00 thru Cut 41, 7+50)							
HJ - Halophillia johnsonii	12855	4697	4304	17552	21856	0.40	0.50
HD - Halophillia decipens	307475	119532	34479	427007	461485	9.80	10.59
HJ w/ HD,HW	99340	25489	19595	124828	144423	2.87	3.32
HW	0	0	3713	0	3713	0.00	0.09
Total HJ Communities	112195	30185	23899	142380	166279	3.27	3.82
Area Total	419670	149717	62090	569387	631477	13.07	14.50
Overall Project Area Summary - All Facilities and Main Channel (Cut 35, 0+00 thru Cut 41, 7+50)							
Seagrass Cover Class	Channel Perm (sqft)	1:3 Slope Perm (sqft)	1:3 Slope Temp (sqft)	Total Perm (sqft)	Total Area Impact (sqft.)	Perm	Est Impact (ac) Total
HJ - Halophillia johnsonii	21500	8445	6313	29945	36258	0.69	0.83
HD - Halophillia decipens	378431	130322	48819	508753	557571	11.68	12.80
HW - Halodule wrightii	113	0	8231	113	8344	0.00	0.19
TT - Thalassia testudium	33217	4646	3243	37863	41106	0.87	0.94
SF - Syringodium filiforme	0	0	0	0	0	0.00	0.00
HJ w/ HD,HW	133386	38930	32847	172315	205162	3.96	4.71
HJ w/ SF,TT	316	209	493	525	1018	0.01	0.02
HD/TT	31302	7084	5938	38386	44324	0.88	1.02
Mixed Seagrass w/o HJ	14556	6449	17297	21005	38302	0.48	0.88
Total HJ Communities	155202	47583	39653	202785	242438	4.66	5.57
Project Area Total	612821	196084	123180	808905	932085	18.57	21.40

Figure 2 Location of Seagrass Communities Subject to Impact



3.1.1 Federal Section

Total estimated seagrass impacts for the four incremental dredging depths (Projects 10,12, 14, and 15) are 9.24 acres, 10.54 acres, 11.92 acres, and 12.20 acres, respectively. Temporary impacts accounted for 10-12% of the total impacts. Total impacts to *H. johnsonii* ranged from 1.97 acres for the Project 10 depth (12 feet) to 2.69 acres for the maximum Project 15 (17-foot) depth. Impacts to *H. decipiens* accounted for over 70% of the total area of seagrass impact. Temporary impacts were also highest in this section of the AIWW due to the high occurrence of *H. decipiens* within and adjacent to the channel in the northern reach of this section near Peanut Island.

3.1.2 FIND Section

Total estimated seagrass impacts for the four incremental dredging depths (Projects 10,12, 14, and 15) are 2.05 acres, 2.15 acres, 2.27 acres, and 2.29 acres, respectively. Temporary impacts accounted for less than 5% of the total impacts. Total impacts to *H. johnsonii* ranged from 1.12 acres for the Project 10 depth (12 feet) to 1.13 acres for the maximum Project 15 depth (17 feet). Due to the infrequent occurrence of seagrass outside the immediate channel, increasing the dredge depth did not greatly increase the seagrass impact. Impacts to *H. decipiens* accounted for approximately 45% of the total area of seagrass impact.

3.2 Facilities

Facilities where seagrass impacts will occur from any dredging include Florida Marine, Perry Technologies, Charter School, and Rybovitch Marina. No seagrass was found within the Palm Beach Municipal Marina survey area. Table 1 summarizes the impacts for each incremental depth. Tables 2-5 document the incremental impacts for each dredging depth specific to each facility for all seagrass cover types found. Figure 2 illustrates the location of seagrass community impacts.

3.2.1 Florida Marine

Total seagrass impacts for each of the four (12, 14, 15, and 17-foot) incremental depths analyzed include 2.12 acres, 2.41 acres, 2.55 acres, and 2.67 acres. Of the total impacts, those associated with *H. johnsonii* only are 0.22 acre for the first three depths and 0.23 acre for the 17-foot increment (Project 15). Temporary impacts for each of the four dredging increments include 0.50 acre, 0.62 acre, 0.62 acre, and 0.71 acre and on the average account for 30% of the total impact acreage. A majority of the impacts are to *H. decipiens*, either as monospecific beds or in association with other species.

3.2.2 Perry Technologies

Total seagrass impacts for each of the four (12, 14, 15 and 17-foot) incremental depths analyzed include 1.60 acres, 1.72 acres, 1.85 acres, and 1.90 acres. Of the total impacts, those associated with *H. johnsonii* only are 0.17 acre, 0.20 acre, 0.23 acre, and 0.25 acre for the four incremental depths, respectively. Temporary impacts for each of the four dredging increments include 0.25 acre, 0.28 acre, 0.31 acre, and 0.35 acre, and on the average account for 16% of the total impact acreage. A majority of the impacts are to *H. decipiens*, either as monospecific beds or in association with other species.

3.3.3 Charter School

Total seagrass impacts for each of the four (12, 14, 15, and 17-foot) incremental depths analyzed include 1.18 acres, 1.24 acres, 1.32 acres, and 1.34 acres. Of the total impacts, those associated with *H. johnsonii* only are 0.86 acre, 0.92acre, 0.99 acre, and 1.01 acres for the four incremental depths, respectively. Temporary impacts for each of the four dredging increments include 0.24 acre, 0.22 acre, 0.23 acre, and 0.21 acre, and on the average account for 17% of the total impact acreage. Seagrass species impacted other than *H. johnsonii* included *Thalassia testudinum* and mixed associations with *H. decipiens* and *H. wrightii*.

3.3.4 Rybovitch Marina

Total seagrass impacts for each of the four (12, 14, 15, and 17 foot) incremental depths analyzed include 0.82acre, 0.89 acre, 0.97 acre, and 0.99 acre. Of the total impacts, those associated with *H. johnsonii* only are 0.20 acre, 0.22 acre, 0.26 acre, and 0.27 acre for the four incremental depths, respectively. Temporary impacts for each of the four dredging increments include 0.14 acre, 0.13 acre, 0.15 acre, and 0.13 acre, and on the average account for 15% of the total impact acreage. Seagrass species impacted other than *H. johnsonii* included monospecific beds of *Thalassia testudinum* and *H. decipiens*, and various mixed associations of seagrass species.

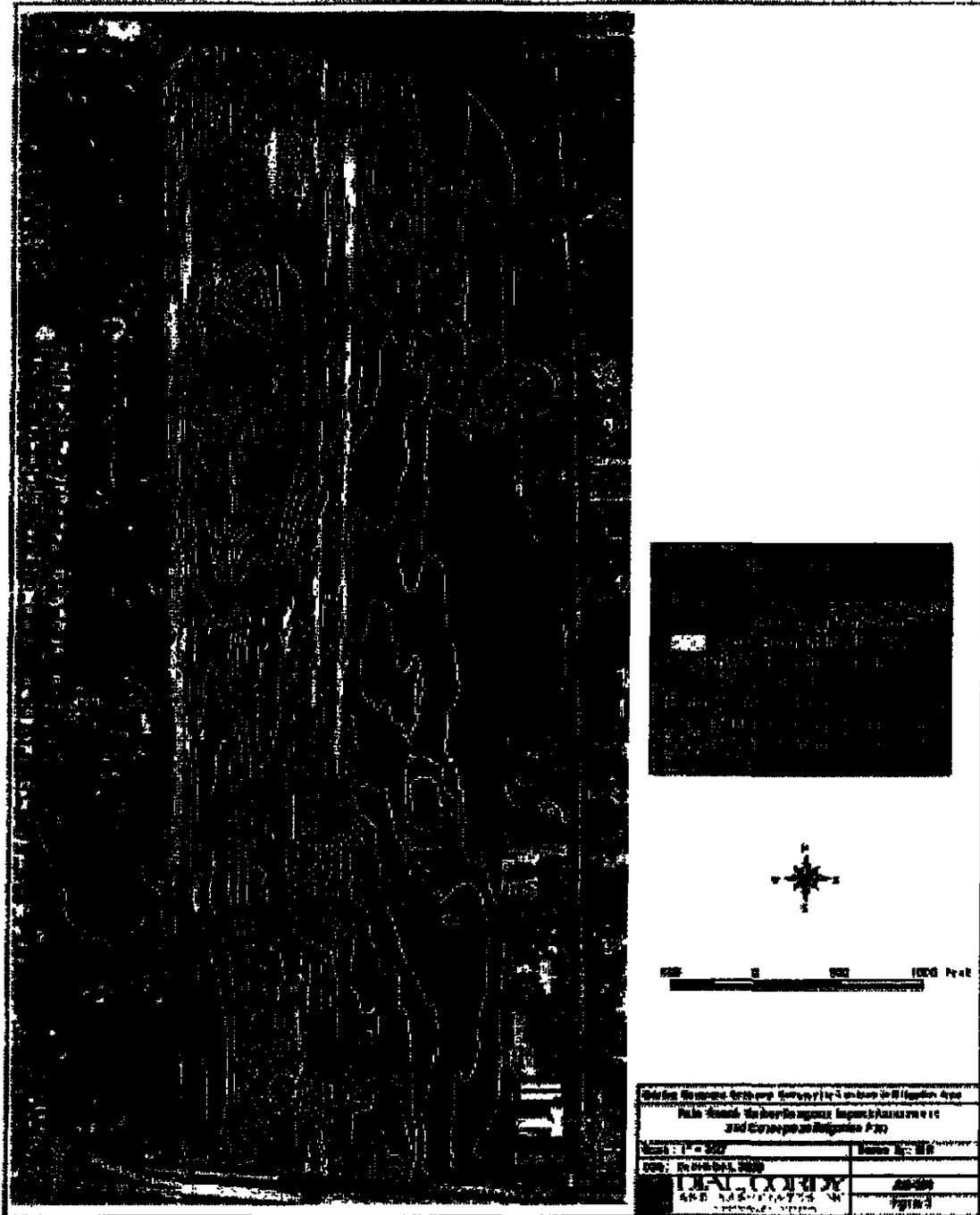
4.0 CONCEPTUAL MITIGATION PLAN

This section includes a description of the existing site conditions, conceptual restoration design, ecological benefits, success criteria and proposed monitoring protocol.

4.1 Site Description

The proposed mitigation area is located just north of the Florida Highway 802 Bridge along the west side of the AIWW (Figure 1). The site is designated as a spoil disposal area on the NOAA chart and as such has been used in the past for fill and disposal purposes. Bathymetric contour maps of the mitigation area and AIWW channel illustrate the considerable variation in depths on each side of the federal channel (Figure 3). While the eastern shore averages less than 6 feet below MSL, the area proposed for seagrass restoration on the west side of the channel averages greater than 10 feet below MSL and has some deeper holes exceeding 20 feet in depth. Sediment is characterized as fine sand with some silt-clay. Water clarity is limited ranging from 2-4 feet depending on the tidal stage and extent of discharge from C-51 canal, located 8 miles south of Palm Beach Harbor.

Figure 3 Existing Seagrass Beds and Bathymetric Contours in Mitigation Area



Based on diver transects within the area west of the channel (Dial Cordy 2000), seagrass occurred only immediately close to shore in less than 5 feet below MSL (Figure 3). Except at the southern end of the site where a mixed seagrass community of *H. johnsonii* with *H. decipiens* and *H. wrightii* occurred, the remaining seagrass cover occurred as monospecific beds of *H. decipiens*, *H. wrightii*, and *H. johnsonii*. Seagrass frequency of occurrence, cover abundance, and density values were measured at five stations surveyed in the proposed mitigation area (Dial Cordy 2000). For *H. johnsonii* frequency of occurrence was 47%, abundance was 0.75, and density was 0.30 at the two stations where observed. For *H. wrightii*, values for frequency of occurrence, abundance, and density were 75% (n=1), 1.50, and 0.30, respectively. *H. decipiens* values were 53% (n=2), 2.00, and 0.80, respectively for frequency of occurrence, abundance, and density.

4.2 Proposed Restoration Design

With a goal of restoring shallow water habitat suitable for the propagation of seagrass species, the proposed design includes using suitable dredge spoil from the proposed channel dredging to raise the existing bottom elevation to depths where, based on survey, seagrass habitat can be either physically planted or allowed to naturally recruit (Figures 4-7). As the depths where seagrass presently occurs ranges from 2-4 feet MSL, filling the spoil site to these elevations to create shallow habitat where light levels are adequate to support photosynthetic production is the basis for the design. To protect planting units and naturally recruited seagrass a narrow subtidal berm will be constructed with fill material landward of the channel (Figures 4-7). This berm will serve to dampen wave energy from boat wakes, thereby protecting planting areas from excessive turbulence, which might disrupt planted seagrass. This approach is being attempted in Tampa Bay as a means of increasing seagrass survival following planting and promoting more rapid recruitment.

In order to expedite natural recruitment, which we expect to occur, seagrass will be relocated from the areas where dredging will occur (donor sites), transplanted in peat pots per methods described in Fonseca et al (1998), and installed in one meter square units throughout the restoration area. Due to the small size and anticipated difficulty in relocating *H. johnsonii*, it is anticipated that seagrass donor sites will be principally located in dense to moderately dense mixed beds of *H. wrightii*, *H. decipiens* and *H. johnsonii*. Peat pots of seagrass will be relocated by divers from the donor sites where dredging is proposed, transported to the restoration site by boat and planted in one meter square plots west of the constructed berm.

One year prior to dredging a pilot study will be conducted to transplant seagrass from donor areas to the shallow areas adjacent to the restoration site. Planting units installed will be covered with wire mesh enclosures to prevent predation and bioturbation. Maintenance of the enclosures will be monthly with monitoring and enclosure removal one year following planting. Planting will include use of donor material from all three species. The results of the study will be used to design the planting methodology for the site restoration. It is anticipated that the full scale planting will include installation of planting units over 5-10% of the total 100 area site. Details of restoration techniques are provided in Fonseca et al (1998) and will be adhered to for this project. Detailed restoration plans and specifications and a monitoring plan for the pilot study should be prepared and thoroughly peer reviewed by experts in seagrass ecology and restoration prior to implementation.

Figure 4 Proposed bathymetric Contours and Estimated Area (ac) to be Filled

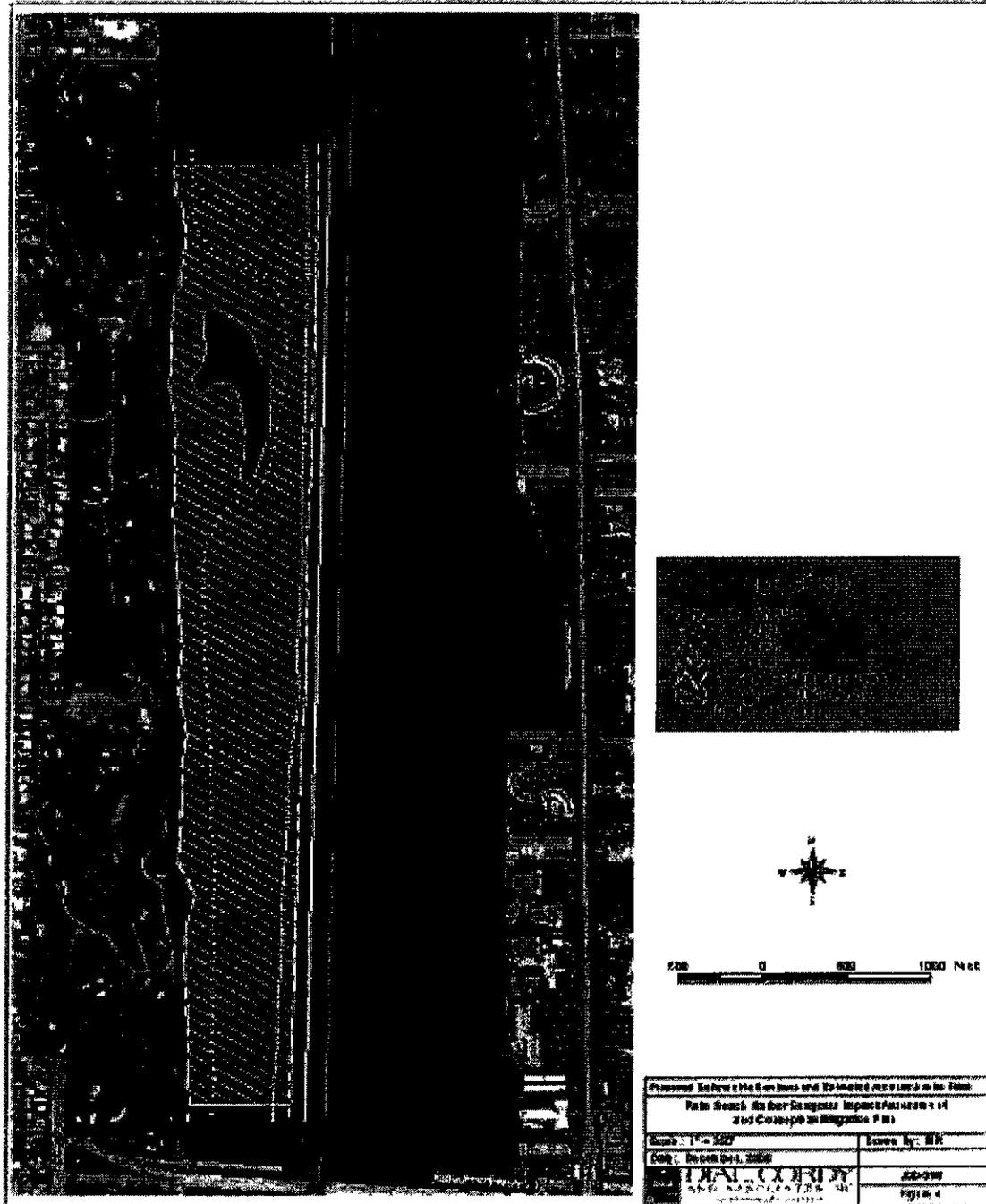


Figure 5 Typical Cross-Section View of Existing and Proposed Elevations (A-A¹)

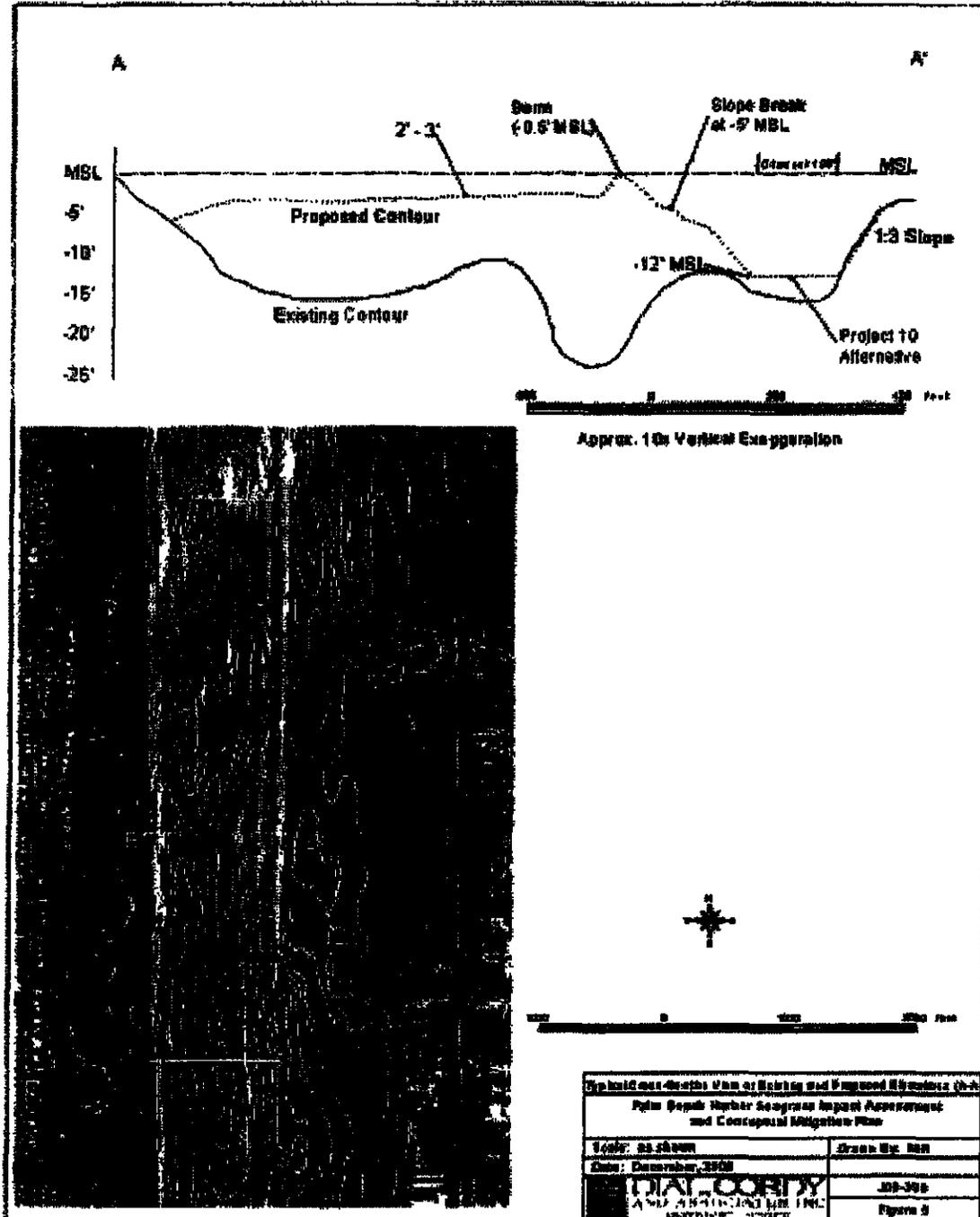


Figure 6 Typical Cross-Section View of Existing and Proposed Elevations (B-B¹)

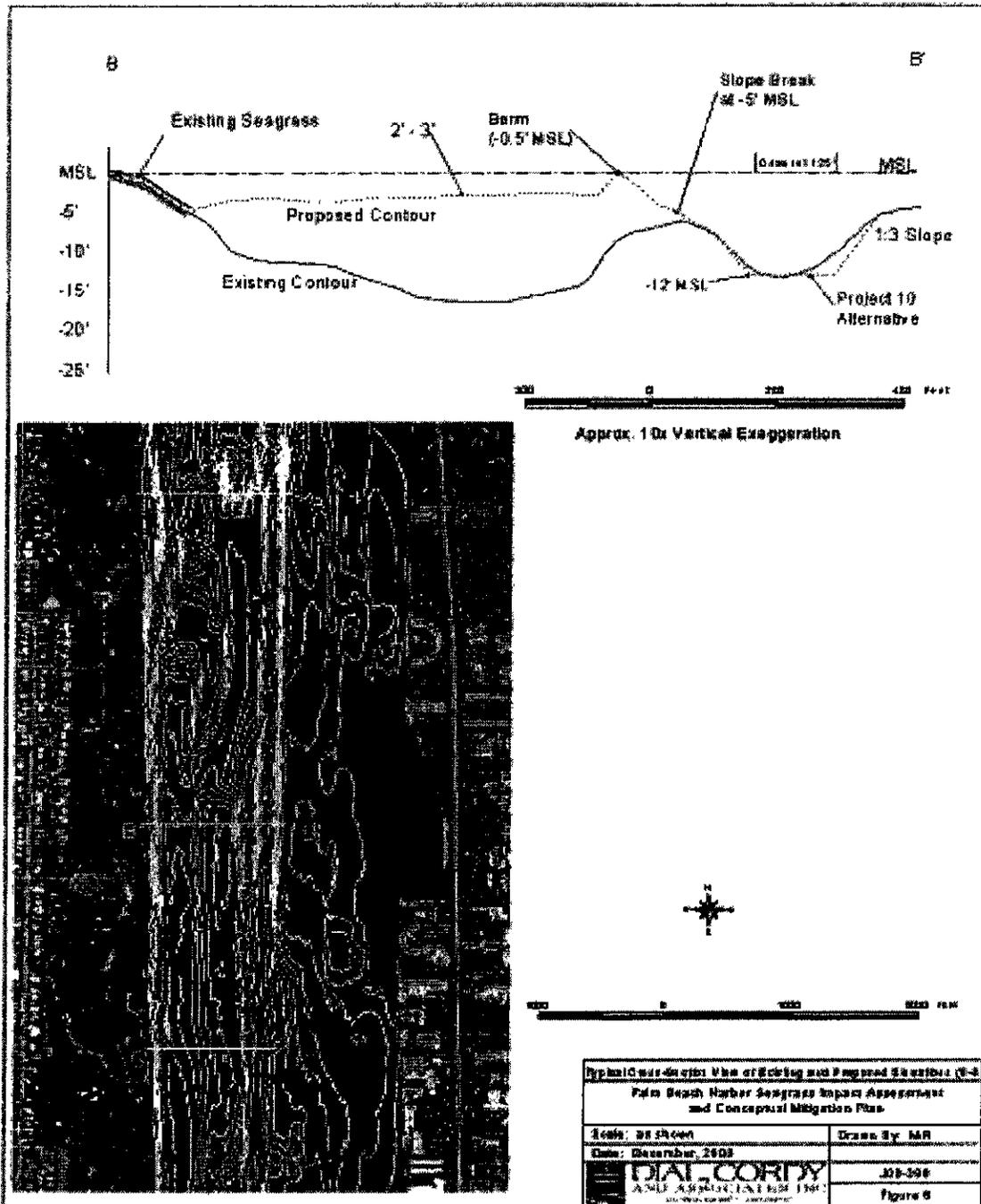
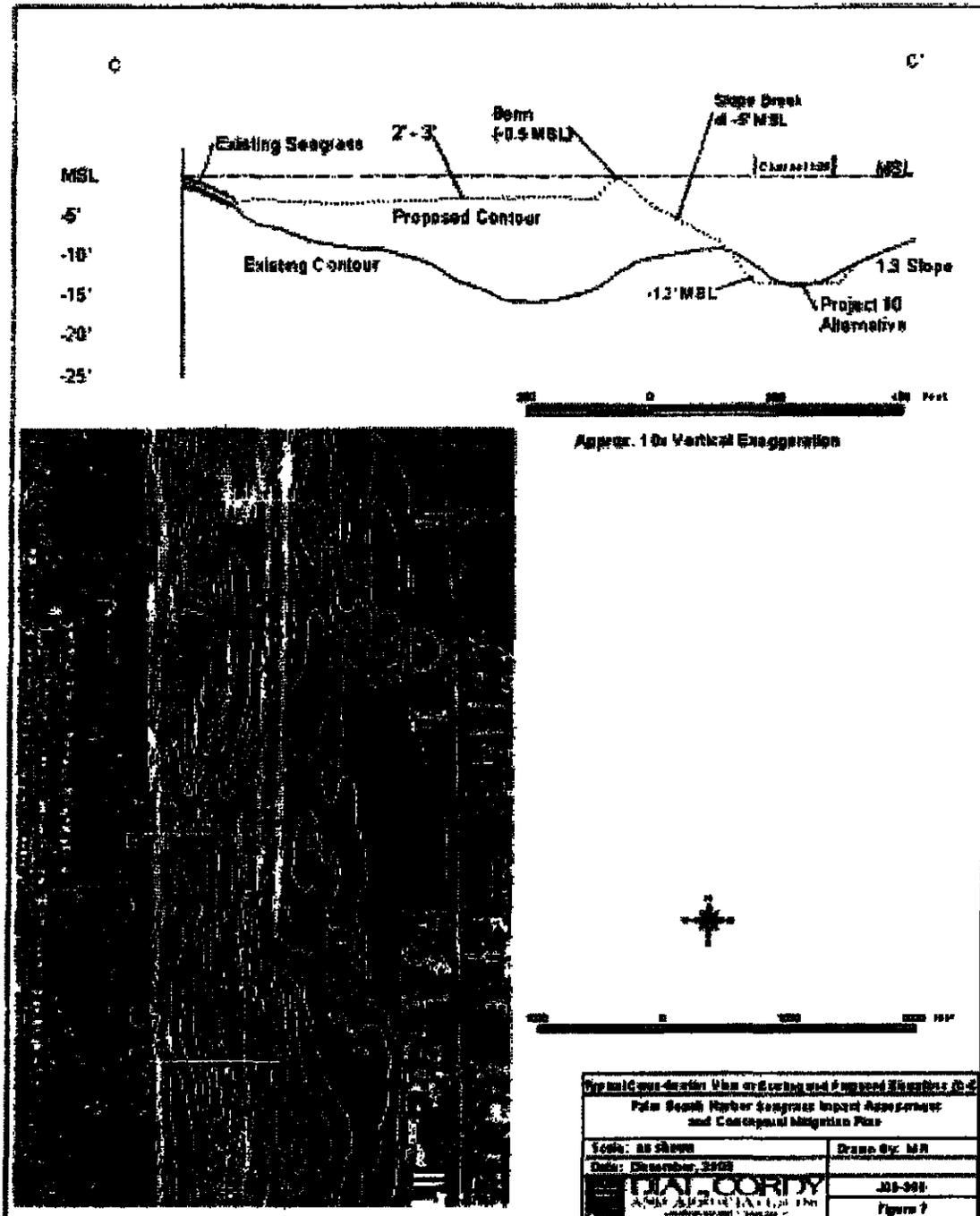


Figure 7 Typical Cross-Section View of Existing and Proposed Elevations (C-C¹)



4.3 Ecological Benefits of Restoration

The ecological benefits of seagrass beds to insular and offshore fisheries, primary production and general food chain support are well known (Zieman 1982). Filling in deep holes and raising the bottom elevation to the photic zone will greatly increase the abundance and diversity of the macrobenthic community which will in turn increase secondary production of larger motile invertebrates and demersal finfish. As a majority of the site is below the photic zone, under anaerobic conditions and with no benthic algae or seagrass present, restoring shallow water habitat will also increase primary production in Lake Worth, as much of the area will be colonized by marine algae and seagrass.

4.4 Success Criteria

The following success criteria are recommended for consideration. These in part are based upon recognition that successful seagrass restoration will require continued replanting for several years to achieve success (Fonseca et al 1998). Success will be defined as the persistence of the required acreage of seagrass coverage for a prescribed period of time, which will be five years for this project.

- Within 1 year after restoration benthic algae and seagrass will be present and expanding from the installed areas and if less than 50 % then additional planting units are to be installed to achieve 75%. Aerobic conditions and active reworking of surficial sediments will be apparent within 1 year of planting.
- Fifty percent of the installed seagrass units have survived and are actively expanding after 2 years and if less than 50 % then additional planting units are to be installed to achieve at least 75 %.
- Sixty percent survival is achieved after 3 years with additional planting as necessary to achieve 75%.
- Sixty-five percent survival is achieved after 4 years with additional planting as necessary to achieve 75%.
- Seventy-five percent survival achieved after 5 years with additional planting as necessary to achieve 75%.
- In the event 75 % survival has not been achieved through replanting efforts five years after planting, consultation with NMFS will be initiated for corrective actions required.

4.5 Monitoring Plan

The monitoring plans presented below are for the pilot study and the full -scale restoration. Monitoring of plant performance for both efforts should utilize standard methods, which best allows for mid-course corrections and improved planning for the major full-scale project (Fonseca et al 1998).

4.5.1 Pre- Dredging Pilot Study

Monitoring should be conducted quarterly for at least one year to determine the percent survival of planting units within each plot, the number of shoots per planting unit and areal coverage. Enclosures should be checked and cleaned monthly if used. Physical/ chemical parameters measured should include conductivity, temperature, dissolved oxygen, and PAR levels. Sediment grain-size and organic content should be sampled at available donor sites and the recipient sites to assess preferences by seagrass species for sediment type. A report summarizing the results of the pilot study should be completed prior to dredging so adequate time is available to adjust the planting techniques and monitoring methodology.

4.5.2 Full Scale Restoration

Pre-Dredging

Prior to dredging a survey should be conducted of proposed donor sites and the restoration site prior to filling in order to establish baseline levels for salinity, dissolved oxygen, PAR, grain-size distribution and organic content.

Post- Restoration

Within 1 year of filling the restoration site with dredged material and capping it with fine sand, the site will have been planted with seagrass planting units in one meter square plots. GPS coordinates will be taken at all planting plot locations to facilitate locating each month. Monthly for the first year only, enclosures will be placed over seagrass plots. Sites will be visited monthly to clean enclosures and to generally note conditions of the plots. On a quarterly basis for the first year and biannually thereafter for five years each plot will be surveyed to estimate percent survival, expressed as shoot numbers, area covered per planting unit and shoot density of the planted seagrass, as well as observe any areas where natural recruitment has occurred. Information will be obtained from all plots and recorded for later analysis. Once planting units begin to coalesce and the installed units can not be discerned, areal coverage and shoot density should be recorded and counts on a planting unit basis suspended. During the first year after the initial planting, physical, chemical and geological

data and or samples will be collected as was done for the pilot study at selected donor sites. This information will be compared to long-term data collected from the restoration site. A ledger will be maintained annually as to number planting units installed each year and the number replanted.

Annual monitoring will be conducted for five years to insure success criteria are met. Monitoring will include survival estimates based on survey of at least 70 % of the meter plot areas, general observations as to the growth and maturation of the planting units, and chemical, sediment and PAR levels at three planting sites within the restoration area. Specific recommendations for monitoring are found in Fonseca et al (1998). Remedial planting will likely be higher the first year and taper off the second and third years. Benthic sampling will occur after the third year of monitoring, with samples pulled from the restoration site and adjacent to the site. Species abundance and richness will be calculated following taxonomic identification. Annual reports will be submitted with an analysis of restoration efforts to date, assessment of plant survival, replanting requirements and recommendations for site improvements.

5.0 LITERATURE CITED

- Bolen, L.E. 1997. Growth dynamics of the seagrass *Halophila johnsonii* from a subtropical estuarine lagoon in southeastern Florida, USA. MS thesis, Florida Atlantic University, Boca Raton, FL. 56pp.
- Dial Cordy & Associates Inc. 1999. Marine Seagrass Survey of the Atlantic Intracoastal Waterway Palm Beach County. Prepared for the Jacksonville District, U.S. Army Corps of Engineers. December 1999.
- Dial Cordy & Associates Inc. 2000. Palm Beach Harbor Marine Resource Survey Draft Report. Prepared for the Jacksonville District, U.S. Army Corps of Engineers. September 2000.
- Fonseca, M. S., W. J. Kenworthy, and G. W. Thayer. 1998. Guidelines for the Conservation and Restoration of Seagrasses in the United States and Adjacent Waters. NOAA Coastal Ocean Program Decision Analysis Series No. 12. NOAA Coastal Ocean Office, Silver Spring, Maryland. 22 pp.
- Gallegos, C.L. and W.J. Kenworthy. 1996. Seagrass depth limits in the Indian River Lagoon (Florida, USA): Application of a water quality optical model. *Estuar. Coast. Shelf Sci.* 42:267-288.
- Kenworthy, W.D. 1993. The distribution, abundance and ecology of *Halophila johnsonii* Eiseman in the lower Indian River, Florida. Final Report to the Office of Protected Resources, National Marine Fisheries Service, Silver Spring, MD 72pp.
- Lotspeich and Associates, Inc. 1998. Draft marine Seagrass Survey for Intracoastal Waterway in Vicinity of Palm Beach harbor. Report prepared for Jacksonville District, U.S. Army Corps of Engineer, Jacksonville, FL.

- Palm Beach County, Department of Environmental Resource Management. 1990. Lake Worth Lagoon Natural Resources Inventory and Resource Enhancement Study. 44pp.
- Post, Buckley, Schuh & Jernigan, Inc. (in progress) Distributional Study of Johnson's Seagrass, *Halophila johnsonii* in Southeast Florida. For Florida Department of Transportation.
- Virnstein, R.W. and L.J. Morris. 1996. Seagrass preservation and restoration: a diagnostic plan for the Indian River Lagoon. Tech. Mem. #14. St. Johns River Water Management District, Palatka, FL. 43pp.
- Zieman, J. C. 1982. The ecology of the seagrasses of South Florida: A community profile. U.S. and Wildlife Service, Office of Biological Services, Washington, D.C. FWS/085-82/25. 158 pp.

